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THE ELEVATION OF THE ERIE RY. tracks through Jersey City, N. J., has been under discussion for some time, and the railway company has now submitted plans for the proposed work. Certain streets will be lowered, and all streets will be crossed by steel bridges with solid floors. Beyond the present terminal station the tracks will rise to the new grade, and continue on that grade to the east end of the present tunnel, passing above that tunnel in open cut and a new tunnel 600 ft. long. Beyond this tunnel the tracks will descend to the existing grade on the Hackensack meadows. Freight trains will descend from the new grade at the east end of the old tunnel, so that the latter will continue to be used for freight service, while the passenger trains will continue on the new grade to a point beyond the new (and shorter) tunnel. The work is estimated to cost about $1,000,000; it is to be commenced in May, 1897, and completed in December, 1898.

A MASONRY VIADUCT INCLINE at Providence, R. I., is proposed by Mr. R. H. Tingley, civil engineer, of that city, to connect Market Square with the high land on the east side. It would be about 1,186 ft. long, with 45-ft. arches designed for use as warehouses. There would be a 30-ft. roadway, and two 10-ft. sidewalks, while on the ground level, at each side, would be a 15-ft. roadway affording access to the warehouses. The proposed grade is 6.4%, and at each end would be a short length of steel viaduct approach.

THE NEW YORK RAPID TRANSIT COMMISSION on Jan. 14 adopted a resolution approving the route for the Rapid Transit railway, which was provisionally adopted a fortnight ago, and was described in our issue of Jan. 7. The two-track extension of the road from the City Hall to the Battery is not to be built unless the consent of the abutting property-holders are secured.

ELECTRIC TRACTION, or some other motive power than steam, is to be adopted by the Cincinnati, Hamilton & Dayton Ry., for its branch line between Middletown and Hamilton, and also for the Middletown Street Ry., which is owned by this company. The two together will make about 16 miles. After this portion of the line is equipped, the company will consider the question of extending the system between Hamilton and Cincinnati. The system to be adopted has not yet been finally determined.

THE ELECTRIC RACK-RAILWAY UP THE JUNGfrau is about to be commenced, and the "Revue Generale des Chemins de Fer" gives the following information concerning it: "The maximum grades will be 25% and the minimum radius of curves is fixed at 100 m., or 328 ft. The motive power will be furnished by two waterfalls, with a combined capacity of 4,500 HP. The electric conductors will be overhead, and the general arrangement of the roadbed will be the same as that adopted on the Mont Saleve electric rack-railway near Geneva. The power plant will be sufficient to keep three trains moving over the road with a combined capacity of 200 passengers. The estimated power necessary is 1,400 HP., divided as follows as to use: For traction, 667 HP.; lighting the tunnels, 50 HP.; lighting the carriages, 8 HP.; heating the carriages, 120 HP.; lighting the stations and handling the elevators at the terminus on the Jungfrau, 200 HP., and for loss in transmission, 280 HP. The total length of the line will be 12,260 m., or 7.6 miles, and the line leaving Petit Scheidigg with an altitude of 2,064 m. above sea level, reaches 4,093 m. at the foot of the elevator at the summit, the total rise in the 7.6 miles being 6,555.32 ft. The speed is limited to 5.3 miles per hour, and the trip to the top will consume 96 minutes. There will be five intermediate stations. The estimated cost is $2,000,000, and the estimated annual receipts are $144,400, of which $134,200 is to come from passengers.

THE HARDIE COMPRESSED AIR LOCOMOTIVE, built at Rome, N. Y., for trial on the Sixth Ave. line of the New York elevated railways, has a reservoir consisting of 36 Mannesman rolled steel tubes, 9 ins. diameter and 15 ft. 6 ins. long. The tubes are of 5-16-in. steel, and are tested to 4,000 lbs. pressure, which is twice the working pressure. The cubic capacity is about 200 cu. ft. Twelve pipes, with three branches to each, connect with the tubes and with a large vertical header, from which a pipe runs to each cylinder. The cylinders are 13½ × 20 ins., and drive two pairs of coupled driving wheels, while a small pony truck is placed under the cab. The working pressure is 150 lbs. The air supply pipe is led through a reheating tank, the water in which is at a temperature of about 300° F. at the start.

A PROPOSED CHARTER REVISION for St. Louis, formulated by a special commission, limits street railway franchises to 25 years and provides that the city shall not sell or lease its water-works plant except pursuant to an ordinance unanimously recommended by the Board of Public Improvements, passed by a seven-eighths vote of the Municipal Assembly, and ratified by a five-sixths vote of the people.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision on the Philadelphia & Reading R. R. at Skillman, N. J., Jan. 16. A local eastbound train from Philadelphia to Bound Brook struck a wagon on a grade-crossing at Hopewell, killing two men and two horses. In consequence of the delay thus caused, the dispatcher ordered the train to run on to the siding at Skillman to let an eastbound express pass. In some way, owing it is said to failure of the brakes, the train overran the siding, the engine and two cars coming out again on the main track just as the express train passed. Three men were killed and six injured. A stove in the baggage car of the local train was upset and set fire to the wreck, and the mail and baggage cars were both burned.

A STEAMSHIP BOILER EXPLOSION occurred Dec. 2 on the French steamer "Saghalien," bound from Singapore to Hong Kong. An engineer and twelve of the firemen are reported to have been killed.

A GASOLINE EXPLOSION occurred Jan. 13 in the "Enterprise" newspaper office at Boscobel, Wis., where the presses were run by a gasoline engine. The building caught fire and was burned to the ground.

A PUDDLE BALL was being carried from the furnace to the squeezer at the Ewald Iron Works, Louisville, Ky., on Jan. 13, when it dropped from the tongs and fell into a tank of water, causing an explosion. Three men were badly scalded.

A POWDER MAGAZINE near Mobile, Ala., was set on fire by sparks from a burning mill, Jan. 19, and a tremendous explosion resulted. Two men were killed and several injured, and considerable damage was done to property in the neighborhood.

A RUNAWAY ELECTRIC CAR on the Penn Ave. line at Pittsburg, Pa., on Jan. 14, jumped the track and struck a telegraph pole. Six persons were hurt. We are informed that this part of the old Citizen's Line, about two miles long, is equipped with electric cars, and as the old cable railway rails have not yet been replaced, they use old cars from other lines of the Consolidated Traction Co. It was one of these cars on which the brake chain broke, and the car, after running about 1,500 ft. on a heavy grade, left the track at a curve.

THE FALLING OF A PIECE OF CORNICE, from the eleventh story of the "Times" building on Park Row, New York, illustrates the danger of using stone for projecting construction in cities. Sandstone was employed in this case, and the Building Department stated that frost was the active agent in causing the accident.

THE SILVER MINES on Carbonate Hill, Leadville, Colo., are being flooded by the stoppage and withdrawal of the drainage pumps at the Maid Henriette Mine, a result of the miners' strike, which has been in progress since June last. Unless a settlement of the strike is soon reached, the stoppage of these pumps will occasion the flooding of a number of other mines further down the hill, which would be a calamity to the Leadville district.

A CENTRAL ELECTRIC LIGHT AND POWER STATION for coal miners' use is said to be planned by a number of coal operators in Jackson, county, O. In the Wellston district, 15 mines will be thus supplied, and 14 in the Coalton district. The substitution of electric machines for hand mining, it is expected, will diminish the trouble from strikes, to which Jackson county has been particularly subject.

ELECTRIC POWER has been used for the last five months in driving two large paper machines, respectively 90 and 102 ins. in size, in the works of the Cliff Paper Co. at Niagara Falls, with entire success. One 150-HP. generator is capable of driving both machines. The great advantages of electric driving is its steadiness and uniformity of speed, which allows the machine tender to keep his paper to uniform weight without difficulty. The output of the machine is from 300 to 350 ft. of paper per minute, or 25 tons per day.

THE $1,000,000 SUIT AGAINST THE TACOMA WATER & Light Co., brought by the city of Tacoma, Wash., in 1894, has been dismissed by the State Supreme Court. In 1893 the city bought the water and light plants of the above company for $1,750,000. There was considerable opposition to the purchase, it being reported that the majority in favor of it, on popular vote, was only about 100. In 1894 the city brought suit to recover $1,000,000 from the company, alleging misrepresentation regarding the yield of certain sources of water supply, the pipe mileage and the land owned by the company. A jury awarded the city $785,000. The State Supreme Court has overruled the award and dismissed the suit on the ground that the award was not sustained by the evidence submitted.

A STATE WATER COMMISSION FOR NEW YORK is proposed in a bill introduced in the senate of that state by Senator Brush. The bill provides that the Governor shall appoint three persons, two of them residents of Greater New York, who, with the state engineer and secretary of the State Board of Health, shall form a board and investigate the whole general subject of water supply for the cities of the state and the feasibility of state construction of reservoirs and conduits for the supply of water to cities and towns. The board is to include in its investigations the Adirondack region, Lakes George, Champlain, Ontario and Erie. The board is authorized to employ engineers and other assistants and to expend $25,000.

WATER PURIFICATION EXPERIMENTS at Pittsburg are recommended by a filtration commission which has been studying the subject in that city for a few months past. The committee originally had $10,000 at its disposal, of which quite a portion remains unexpended. It now asks for $15,000 additional, in order that it may employ an expert and conduct exhaustive experiments. Simple sand filtration, it thinks, would not do at Pittsburg, although this might be successful if preceded by sedimentation. Mechanical filtration seems to be regarded favorably by the commission. The report is signed by Robert Pitcairn, S. D. Warmcastle, H. P. Ford, W. J. Holland, Jas. M. Bailey, J. Guy McCandless, J. R. Vincent, Wm. McConway, Edw. M. Bigelow, Wm. Flinn and G. L. Holliday.

AN ALLEGED CAST-IRON PIPE TRUST is under investigation by the United States Court at Chattanooga. The original bill asked for an injunction prohibiting shipments by the trust from one state to another. In response, the court issued an order on Dec. 10, 1896, prohibiting the defendants from shipping pipe from one state to another without first giving a bond. A petition for an amended bill has just been filed by Mr. Judson Harmon, U. S. Attorney-General, and Mr. Jos. H. Bible, U. S. District Attorney. This petition states that in December, 1894, the estimated annual capacities of the several plants included in the trust were as follows, the plants being indicated by location, only: South Pittsburg, 15,000 tons; Anniston, 30,000 tons; Chattanooga, 40,000 tons; Bessemer, Louisville and Cincinnati, 45,000 tons, each; total, 220,000 tons. The agreement between the members of the trust is cited in some detail, the main allegations being, in effect, that competition was prevented and that the excess prices obtained were divided between the members of the trust, all in accordance with a carefully pre-arranged plan.

BOILER INSPECTION BY CITY OFFICIALS seems to be very efficient in Philadelphia. The report of the Chief Inspector states that there were no explosions during the years 1896 of the boilers under the jurisdiction of his department, which numbered 3,765. Besides these boilers, there are 3,083 others in the city under the care of insurance companies. The report does not say whether or not any of these exploded.

TWELVE-WHEEL PUSHER LOCOMOTIVE, FOR THE BUFFALO, ROCHESTER & PITTSBURG RY.

The use of helper or pusher engines is very common on railways having heavy traffic over steep grades, and this is particularly the case on roads with coal or ore traffic. The object of this is, of course, to enable the road engines to haul their standard train loads for the entire length of the run, instead of having to break up the trains and haul them in sections over the heavy grades. The increase in car capacity and in train loads has made it necessary in many cases to employ specially heavy engines for this pusher service, and we illustrate herewith an enormous engine of

TWELVE-WHEEL PUSHER ENGINE; BUFFALO, ROCHESTER & PITTSBURG RY.
C. E. Turner, Superintendent of Motive Power. Brooks Locomotive Works, Builders.

the twelve-wheel type built by the Brooks Locomotive Works, of Dunkirk, N. Y., for the Buffalo, Rochester & Pittsburg Ry. It is to run on a grade of 58 ft. per mile (1.1%), the length of run being 17 miles, and its service will be the helping of heavy coal trains over this grade.

The enormous size of this engine is at once apparent from the illustration, and there are many peculiarities in the details of the design. Among these may be noted the iron ladder from the running board to the sandbox, the placing of the brake pumps under the front end of the boiler barrel, the placing of the smokestack at the front end of the extension smokebox, and the unusually good design of steps to the tender deck. The cab is of steel plates with a wide window opening in each side, and automatic couplers are fitted to the engine and tender. The headlight is of the circular pattern now so generally used. The general dimensions are given below in our standard form:

Twelve-Wheel Pusher Engine; B., R. & P. Ry.

Running Gear:	
Driving wheels, diam.	4 ft. 7 ins.
Truck " "	2 " 4 "
Tender " "	2 " 9 "
Engine truck	Swing center.
Journals, driving axles	8½ × 10 ins.
" truck axles	5½ × 10½ "
" tender axles	4¼ × 8 "
Wheel Base:	
Driving	15 ft. 6 ins.
Truck	5 " 10 "
Total engine	25 " 5 "
" tender	16 " 6 "
" engine and tender	52 " 9 "
Center of truck pin to center of leading driver	7 " 0 "
Wheels having blind tires	Second and third pairs.
Weight in Working Order:	
On driving wheels	148,000 lbs.
On truck wheels	27,000 "
Engine, total	175,000 "
Tender, total	90,000 "
Engine and tender, loaded	265,000 "
Tender, empty	37,350 "
Cylinders	21 × 26 ins.
Distance center to center	7 ft. 3 ins.
" center to valve face	1 " 5¾ "
Piston rod, diameter	4 "
Form of crosshead and guides	Alligator
Connecting rod, length between centers	8 ft. 7 ins.
Valve Gear—Type	Shifting link.
Steam ports	18½ × 1⅝ ins.
Exhaust ports	18½ × 3 "
Slide valves; lap, inside 3-32-in.; outside	⅞-in.
" " lead	1-16-in.
" " max. travel	6 ins.
Boiler.—Improved Belpaire Wagon-Top	Player patent.
Diameter of barrel inside	5 ft. 6¾ ins.
Thickness of barrel plates	⅝-in.
Thickness of smokebox tube plate	⅝-in.
Height from rail to center line	8 ft. 9½ ins.
Length of smokebox	5 " 1 "
Working steam pressure	180 lbs.
Firebox.—Type	Belpaire, over frames.
Length inside	9 ft. 6 ins.
Width inside	3 " 2½ "
Depth at front	6 " 5 "
Depth at back	6 " 2 "
Thickness of side plates	5-16-in.
" back plate	⅜ "
" crown sheet	⅜ "
" tube sheet	⅝ "
Grate area	30.4 sq. ft.
Staybolts, diameter, 1 in.; pitch	4¼ ins.
Water space, width, front and back, 4 ins.; sides, 3½ "	
Tubes.—Material, iron	No. 324
Pitch	2⅞ ins.
Diameter, outside	2 "
Length between tube plates	12 ft. 7 5-16 ins.
Heating Surface:	
Tubes, exterior	2,106 sq. ft.
Arch pipes	24 " "
Firebox	201 " "
Total, with exterior tube area	2,331 " "
Miscellaneous:	
Exhaust nozzle, diameter	5, 5¼, 5½ ins.
Smokestack, smallest diameter	1 ft. 5 "
Smokestack, height from rail to top	14 " 5 "
Capacity of tank	4,500 gallons
Brake fittings	New York Air Brake

The following table gives comparative dimensions of some heavy pusher engines of recent design on five railways:

Dimensions of Pusher Engines.

	Railways.				
	Buffalo, Roch. & Pitts.	Can. Pac.	Pitts., C., C. & St. L. (tank.)	Erie.	Burl. & Mo. River.
No. of wheels.					
Driving	8	8	8	10	10
Truck	4	2	0	2	0
Diam. drvg whls, ins.	55	47&50	50	50	40
Cylinders, ins.	21×26	20×26	22×28	*....	22×28
Weight, lbs.:					
Total	175,000	.....	140,000	192,600	150,300
On driving wheels	148,000	.....	140,000	170,000	150,300
Per driving wheel	18,500	.....	17,500	17,000	15,300

*(4) 16 and 27×28.

PAPER FRICTION WHEELS.*

By W. F. M. Goss, M. Am. Soc. M. E.†

If two toothless wheels are pressed face to face, the rotation of one will tend to turn the other, and under favorable conditions power may be transmitted from the driver to the follower. Such an arrangement may employ all the forms common to toothed gearing, but as the contact is one of pure rolling such gearing is freed from some of the limitations which govern the use of toothed wheels. For example, in friction gearing the driven wheel may be disengaged and stopped without danger of shock, while the driver continues its motion, or if out of gear it may as readily be started, its speed accelerating until it becomes normal.

The amount of power which can be transmitted by friction gearing depends upon the characteristics of the material used in the two wheels which run in contact. As usually constructed the driver is made of yielding material, such as wood, raw-hide, leather, or india rubber, while the driven wheel is almost invariably of cast iron. Such combinations have the advantage of producing a high coefficient of friction between the wheels; and again, if there is slippage, it is the harder wheel that stops, and upon this the continuous motion of the softer driver inflicts no damage. Until quite recently all such gearing has been of light construction, and the power transmitted correspondingly small, and so long as leather and raw-hide continued to be the materials most preferred for the construction of drivers, no very heavy work was practicable.

There has recently appeared, however, a new material which seems well suited to the requirements of friction wheels. This is compressed straw-board, and, as in belt transmission the paper pulley has earned for itself a well-merited place, so in frictional work the paper friction wheel is fast paving its way to general recognition. These wheels are composed of thin disks of straw-board cemented together under heavy pressure and strengthened by iron side-plates, or fitted over iron centers. By this construction, the face of the wheel presents the edges of the straw-board disks, and these give a surface which takes a good finish when turned, and which works perfectly in rolling contact with cast iron.

Some of the applications of the paper friction wheels are presented diagrammatically herewith. Fig. 1 shows a plain gearing connecting parallel shafts. Friction wheels of this form are in service which are capable of transmitting 25 HP. or more. A three-wheel gearing, which is considerably used as an element in the feed mechanism of certain sawmill machinery, is shown in Fig. 2, the combination being one in which a paper wheel acts as a medium by which motion is transferred from one iron wheel to another. Another typical gearing is shown in Fig. 3. If the paper driver of this gearing is forced against the rim a, a forward motion of the follower results, while if the driver is brought in contact with b, a reversed motion at higher speed is obtained—an arrangement which has been found serviceable on screw presses. Beveled paper friction wheels of the form shown by Fig. 4 are being made of such size as will permit their use for driving shop shafting, while Fig. 5 shows a device which has been employed for giving motion, in either direction, to the spindle of a well-known shaping and panel-carving machine.

In the absence of data which would serve as a basis for calculating the amount of power which any paper wheel can transmit, an experimental study of the problem was resolved upon, and with this end in view apparatus was devised which is shown diagrammatically by Fig. 6. The shaft A of this figure runs in fixed bearings and carries the paper friction wheel: it is designed to be driven by belting from any convenient source of power, the direction of the motion being that indicated by the arrow. The shaft B carries the iron follower and the brake wheel. The bearings of this shaft are capable of receiving motion in a horizontal direction, and by means of suitable mechanism connected with them, the iron follower may be made to press against the paper driver with any force desired. The pressure exerted by B upon A is the "pressure of contact," and is represented by P. Through the action of the brake, the tendency of the iron wheel to revolve with the paper wheel may be resisted to any desired degree, and the theory of the machine assumes that the energy absorbed by the brake is equal to that transmitted from the driver to the follower at their point of contact, C. The resisting force of the brake may readily be reduced to an equivalent force, F, acting at the circumference of the follower, and

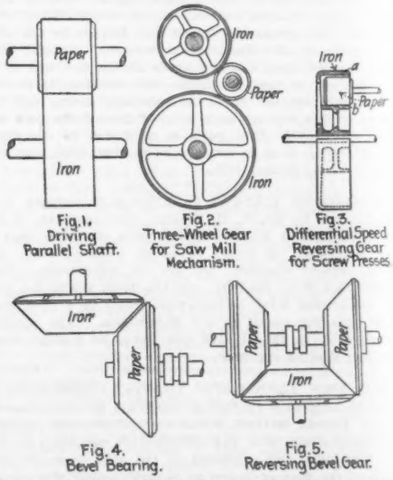


Fig. 1. Driving Parallel Shaft. Fig. 2. Three-Wheel Gear for Saw Mill Mechanism. Fig. 3. Differential Speed Reversing Gear for Screw Presses. Fig. 4. Bevel Bearing. Fig. 5. Reversing Bevel Gear.

Figs. 1 to 5.—Recent Applications of Paper Friction Wheels

its value may be accepted as the force actually transmitted from one wheel to the other at the point of contact, C.

From this brief description, it will be evident that the functions of the apparatus are such as will permit a study of the relationship existing between F and P, which relationship may be expressed as the coefficient of friction, thus:

$$f = \frac{F}{P}$$

Other things being equal, the power which can be transmitted by any such gearing will vary directly with the coefficient of friction.

The actual machine used is shown by Fig. 7. It meets all the conditions which have been defined, excepting that the shaft, B, does not run in frictionless bearings, as a strict adherence to the assumed theory would require. It

*A paper presented at the New York meeting of the American Society of Mechanical Engineers.

†Professor of Mechanical Engineering, Purdue University, Lafayette, Ind.

is thought that, during the experiments, the journal friction at B was fairly constant, and that its value was always small as compared with that of the forces transmitted by the gearing. Its effect, so far as it may have had an effect, would have been to reduce the value of the observed coefficient of friction. The values as observed, however, are doubtless better for the purposes in hand than a true value, since the employment of friction wheels in practice will generally involve losses by journal friction similar to

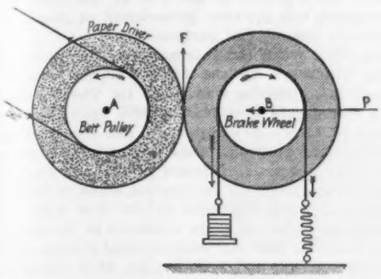


Fig. 6.—Section of Apparatus for Testing Friction Gearing.

those existing during the progress of the experiments in question.

By reference to Fig. 7, it will be seen that the fixed bearings of shaft A are fitted between guides in such a manner as to allow the bearings of the shaft to be blocked out towards B, in case a friction wheel is to be experimented upon which is much smaller in diameter than the one shown. The bearings of B slide at a good fit between the guides in the frame, and the pressure of contact between the friction wheels is secured by weights on the holder E, acting through a bell-crank and suitable connecting links. The fulcrum of the bell-crank is in a block G, which may be adjusted by the hand-wheel H, thus allowing the arms of the bell-crank to be brought to their normal position, and in this way offsetting slight variations in the diameter of the friction wheels. Power was delivered to A by two 3-in. belts, and was absorbed at B by a rope dynamometer. Slippage was determined from readings of counters taken simultaneously from each shaft.

In carrying out the experiments it was found convenient first to load the weight holder E, Fig. 7, and then to bring the bell-crank to its normal position by adjusting the trunnion block G; the follower was thus made to roll with the driver under a definite pressure of contact. By applying the brake a light resistance was then introduced to oppose the motion of the driven shaft, and this was maintained constant for a sufficient period to allow observations to be made for slip.

The pressure of contact, the load on the brake, and the slip having been observed, a new set of conditions was obtained by increasing the brake-load, after which, observations were repeated. In this manner a series of observations was made under a constant pressure of contact, but at different brake-loads; and as each increment of brake-load increased the slip, the resulting data gave the relation between the per cent. of slippage and the force transmitted for the pressure of contact chosen. When the brake-load had been so much increased as to make the slippage excessive, a new value for the pressure of contact was chosen, and the whole process as already described was repeated.

The results were finally grouped for purposes of comparison, in such a manner as would make each group present but a single variable factor (Fig. 8).

The experiments involved paper friction wheels of approximately 5½, 8, 12, and 16 ins. diameter, all in contact with a 16-in. cast-iron wheel. The contact pressure was varied from 75 lbs. per in. of width to more than 400 lbs., and the speed limits gave a peripheral velocity varying from 450 to 2,700 ft. per minute. In an effort to eliminate all inconsistencies the work was many times repeated, the whole process involving more than 5,000 observations.

The following is summary of the results:*

Slippage.—By increasing the load to be carried, the slippage may always be gradually increased to 3%, and under favorable conditions its gradual increase may reach a maximum of 6%, but when the slippage is between the limits of 3% and 6% it is likely to undergo a rapid increase to 100%; that is, the driven wheel is likely to stop.

The Coefficient of Friction depends upon conditions some of which have not been studied and are not understood. It is most affected by slippage. Its value increases with increase of slip until the latter becomes about 3%, after which the action of the gearing becomes uncertain. With a slippage of 2%, the maximum value of the coefficient rises above 25%, and as the slippage approaches 3%, even larger values have been observed.

The coefficient of friction is apparently constant for all pressures of contact up to a limit which lies between 150 and 200 lbs. per in. of width of wheel-face, beyond which limit its value decreases. At 400 lbs. pressure its value is from 10% to 15% less than for 150 lbs.

Friction wheels of 8, 12, and 16 ins. diameter give nearly the same value for the coefficient, while results from a 6-in. wheel are lower by about 10%—a fact which would seem to indicate that wheels smaller than those experimented upon may have a still lower value for their co-efficient.

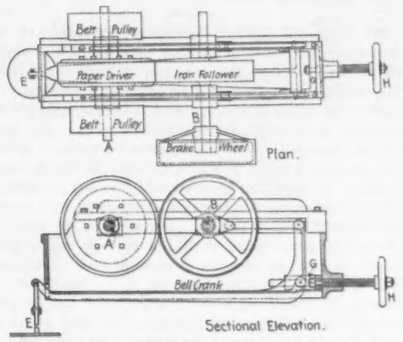


Fig. 7.—Plan and Elevation of Testing Apparatus.

Variations in peripheral speed between 400 and 2,800 ft. per minute do not affect the coefficient of friction.

Pressure of Contact.—With a constant co-efficient of friction, the power transmitted varies directly with the pressure of contact. During the comparatively short period covered by the experiments, the paper wheels gave no indications of breaking down under pressure as high as 400 lbs. per in. in width. The work was not continued through a period sufficiently long, however, to permit a determination of the maximum pressure with which paper drivers may be forced against their iron followers; but it has already been noted that the coefficient of friction is maximum under a pressure of about 150 lbs. per in. in width, and while the amount of power delivered may be augmented by increasing the pressure above this limit, the most efficient pressure is that for which the coefficient of friction is maximum.

Horse-Power.—By making d the diameter of the friction wheel in inches, w the width of its face also in inches, and N the revolutions per minute, and by accepting 0.2 as a safe value for the coefficient of friction, and a pressure of 150 lbs. per in. width of face as the pressure of contact, the horse-power may be written as,

$$HP. = \frac{150 \times 0.2 \times \frac{1}{12} \pi d \times W \times N}{33000} = .000238\ d\ W\ N.$$

This formula is believed to be safe for friction wheels which are 8 ins. or more in diameter, and under conditions which make it possible for them to be kept reasonably clean. By its use the accompanying table has been calculated:

Horse-Power which May be Transmitted by Means of a Clean Paper Friction Wheel of 1-in. Face When Run Under a Pressure of 150 lbs.

Diameter of pulley, ins.	Revolutions per Minute. 25	50	75	100	150	200	300	400	600	800	1000
4	.0238	.0476	.0714	.0952	.1428	.1904	.2856	.3808	.5712	.7616	.9520
6	.0357	.0714	.1071	.1428	.2142	.2856	.4284	.5712	.8568	1.1424	1.428
8	.0476	.0952	.1428	.1904	.2856	.3808	.5712	.7616	1.1424	1.5232	1.904
10	.0595	.1190	.1785	.2380	.3570	.4760	.7140	.9520	1.4280	1.9040	2.380
14	.0833	.1666	.2499	.3332	.4998	.6664	.9996	1.3328	1.9992	2.6656	3.332
16	.0952	.1904	.2856	.3808	.5712	.7616	1.1424	1.5232	2.2848	3.0464	3.808
18	.1071	.2142	.3213	.4284	.6426	.8568	1.2852	1.7136	2.5704	3.4272	4.284
24	.1428	.2856	.4284	.5712	.8568	1.1424	1.7136	2.2848	3.4272	4.5696	5.712
30	.1785	.3570	.5355	.7140	1.0710	1.4280	2.1420	2.8560	4.2840	5.7120	7.140
36	.2142	.4284	.6426	.8568	1.2852	1.7136	2.5704	3.4272	5.1408	6.8544	8.568
42	.2499	.4998	.7497	.9996	1.4994	1.9992	2.9988	3.9984	5.9976	7.9968	9.996
48	.2856	.5712	.8568	1.1424	1.7136	2.2848	3.4272	4.5696	6.8544	9.1392	11.424

STANDARD DIMENSIONS FOR FREIGHT CARS OF 60,000 LBS. CAPACITY.

An investigation as to the standard dimensions adopted or recommended by various car building companies and master-car-builders was recently instituted by the Ohio Falls Car Co., of Jeffersonville, Ky., with a view to the formulating of a uniform set of standard dimensions for general use. The company reports that the effort to establish a standard 60,000-lb. car has met with much greater support than was anticipated, this support being shown by the favorable expression individually of a large number of railway officials and car builders. It is the opinion of the majority interested that the movement should have a wider scope than first intended, and should embrace every important part left undecided by the convention of the Master Car Builders' Association, in June, and it has therefore been decided to continue the development of this plan until the convention announces its decision, and to add to the standards then adopted an agreement covering as many parts as the car builders will unite upon.

The accompanying table gives a summary of the standards of the car-building companies which have sent in reports. It is pointed out that the variations are slight, but are yet sufficient to prevent interchangeability, thus emphasizing the desirability and feasibility of the adoption of a standard car:

Standards Existing and Proposed for a 60,000-lb. Box Car.

	Barney & Smith Car Co.	"Locomotive Engineering."	Terre Haute Car & Mfg. Co.	Elliot Car Co.	Ohio Falls Car Mfg. Co.	United States Car Co.
	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.
Length inside, clear	33 0½	36 ..	33 6	34 ..	34 ..	33 4¼
Width inside, clear	8 3½	8 ..	8 4	8 ..	8 2¼	8 1¼
Height inside, clear	7 2	7 ..	6 9	6 11	6 8¼	7 0¼
Door opening	5 ..	5 6	5 ..	6 ..	5 6	5×6 6½
Center ties, distance c. to c.	6 10½	8 10	4 6	6 9	6 3	8 ..
Height of lining	3 6	7 ..	3 6	4 ..	4 ..	2 6
Truss rods, diameter of shank	.. 1¼	.. 1⅜	.. 1½	.. 1½	.. 1⅛	.. 1¼
Truss rods, diameter at end	.. 1⅞	.. 1¾	.. 1⅞	.. 1⅝	.. 1⅞	.. 1½
Wheelbase of truck	4 10	5 ..	5 ..	5 6	5 ..	5 ..
	—ins.—	—ins.—	—ins.—	—ins.—	—ins.—	—ins.—
Side sills	5 × 8½	5 × 9	5 × 9	5 ×10	5 × 9	5 × 9
Center sills	5 × 8½	5 × 9	5 × 9	4 ×10	5 × 8½	5 × 9
Intermediate sills	5 × 8½	5 × 9	4 × 9	4 ×10	5 × 8½	5 × 9
Side plates	3½× 7	.....	4 × 6	.....	3 × 6	3 × 8
End plates	3½×12	.....	.....	.....	3½×12	3 ×13
Upper arch bar of truck	4 × 1¼	1 × 4	1¼× 4	1¼× 4	1¼× 4	1¼× 4
Lower arch bar of truck	4 × 1⅛	1 × 4	⅞× 4	1⅛× 4	1 × 4	1 × 4
Tie bar of truck	4 × ⅝	⅝× 4	⅝× 4	⅝× 4	½× 4	⅝× 4
Set of upper arch bar	.....	6	.....	.....	5	5
Set of lower arch bar	.....	14	.....	.....	12	13
Set of tie bar	.....	.....	.....	.....	1	2⅝
Column bolts, diameter	1⅛	1¼	.. 1⅛	.. 1¼	.. 1¼	.. 1¼
Oil box bolts, diameter	1⅛	1⅛	.. 1⅛	.. 1	.. 1	.. 1⅛

THE WORLD'S SHIPPING FOR 1896, says a statement issued by Lloyds', shows a net increase for that year of 842,000 tons in the mercantile navy alone. The sailing tonnage was reduced by 264,000 tons and the steam tonnage was increased by 1,106,000 tons. The total number of ships built in the world in 1896 was 1,205, divided as follows: 888 steam vessels, 225 sailing ships and 92 war ships. Of this total, 299,421 tons of steam vessels and 108,710 tons of sailing ships were built outside of England. During 1896, exclusive of war ships, 696 vessels, or 628 steamers and 68 sailing ships, were launched in Great Britain. In the same year England launched 55 warships, for all nations, of 163,958 tons displacement, making 751 vessels of all kinds launched in the year, with an aggregate displacement of 1,323,709 tons. Sailing vessels, which formed 24% of the output of 1892, only figure at 4% in 1896. Of the steam tonnage 99.3% were built of steel, and only 0.65% of iron, and of the sailing vessels 96.2% were built of steel and 3.2% of wood. About 30% of the total output in England was built for foreign and Colonial ship owners, the bulk of this trade being for Germany, with Russia, Norway, Denmark and Japan following in the order named.

*In presenting the results of the experiments which have been described, the writer acknowledges the assistance of Prof. M. J. Golden, who worked up the details of the testing-machine, Fig. 7; of the Rockwood Manufacturing Company of Indianapolis, through whose courtesy all necessary friction wheels were supplied; and of Messrs. Robt. D. Hawkins, M. E. '95, and T. E. Layden, B.S., '96, who as students in the Purdue laboratory conducted the experimental work.

THE PRESIDENTS OF FOUR AMERICAN ENGINEERING SOCIETIES.

(With portraits.)

In accordance with the practice which we established a year ago, we present this week on an inset sheet the portraits of the presidents of four national engineering societies, and give also some notes of the life and professional career of each of these gentlemen.

Mr. Benjamin Morgan Harrod, who has just been elected President of the American Society of Civil Engineers, was born in New Orleans, La., in 1837, and graduated from Harvard College in 1856. He spent several years in further study after leaving college, and was then employed, in 1858, as a draftsman and Assistant Engineer in the U. S. Lighthouse and Engineers' District, covering a territory extending from the Mississippi River to the Rio Grande. Between 1859 and 1861 he was in private practice in New Orleans, and on the outbreak of the Civil War he entered the Confederate service, and was on duty as a Division Engineer and as an officer of Engineer troops.

From the close of the Civil War to 1877 he was again in private practice, with his office in New Orleans. In 1877 he was appointed State Engineer of Louisiana, but resigned in 1879 to accept an appointment as a member of the Mississippi River Commission. From 1888 to 1892 Mr. Harrod was City Engineer of New Orleans, and he has lately been appointed the Engineer of the Drainage Commission of that city to carry into execution a drainage plan prepared by City Engineer L. W. Brown, in consultation with an advisory board composed of Messrs. H. B. Richardson, Rudolph Hering and Mr. Harrod himself, all Members of the American Society of Civil Engineers. This plan contemplates the artificial drainage of the level alluvial tract which is the site of the city, at an estimated cost of about $7,000,000.

Mr. Harrod was elected a Member of the American Society of Civil Engineers on April 4, 1877, and has been Vice-President of that Society for the last two years. He has contributed several papers to the "Transactions" of the Society upon the reclamation of the alluvial lands of the Mississippi Valley, the dangers threatening navigation on the Mississippi River, and on the preservation of timber, on rainfall, etc.

Mr. Worcester R. Warner, who was elected President of the American Society of Mechanical Engineers at the New York meeting held in December, is a member of the well-known firm of Warner & Swasey, of Cleveland, O., which, in addition to its reputation for building high-class machine tools, has achieved a world-wide fame in the designing and construction of telescopes and other astronomical instruments. The 36-in. telescope for the Lick Observatory in California and the 40-in. telescope for the Yerkes Observatory, the two largest refracting telescopes in the world, were, with the exception of the lenses, built by this firm.

Mr. Warner began life on a New England farm, which had been the homestead of the family for four generations, located in the town of Cummington, in Western Massachusetts, which was also the birthplace of William Cullen Bryant. He early showed a taste for mechanical and scientific pursuits, and in the year 1865, at the age of 19, he entered the office of Mr. George B. Brayton in Boston to learn drafting and designing. At the end of a year he went into the Exeter Machine Works, Exeter, N. H., where he worked at the machinist's trade. In 1870, together with Mr. Ambrose Swasey, his present partner, he entered the employ of Pratt & Whitney, the well-known machine tool builders, of Hartford, Conn. Here he had charge of one of the departments, and was also manager of the company's exhibit at the Centennial exhibition in Philadelphia. During the years spent in the machine shop he continued his private studies, both of engineering and astronomy, in which latter science he took great interest. In 1881 he and Mr. Swasey established the firm of Warner & Swasey, in Cleveland, building a machine shop for the manufacture of machine tools and special machinery, which at once took high rank for the quality of its work. At that date it was scarcely possible to find west of Philadelphia a shop capable of doing fine work of the class that is done in New England, and Mr. Warner and his partner were about the first to transplant New England methods of machine shop practice to western soil. The astronomical studies of Mr. Warner soon led his shop into the specialty of designing and making telescopes and other instruments for observatories, and in their design the old methods of the instrument maker were disregarded and those of the mechanical engineer used, with such success that Warner & Swasey are now recognized as leading instrument builders by astronomers throughout the world. Mr. Warner still continues his astronomical studies, and has a private observatory, containing a 10½-in. telescope, located between his residence and that of Mr. Swasey on Euclid Ave. He is often called upon to lecture on astronomy. Mr. Warner is a past president of the Civil Engineers' Club, of Cleveland, and is a trustee of the Case School of Applied Science. He has been a Member of the American Society of Mechanical Engineers since its organization in 1880.

Mr. Edmund Gybbon Spilsbury, President of the American Institute of Mining Engineers, was elected to that office at the meeting in February, 1896. He was born in England in 1845, and received his early education in France and Belgium, and a subsequent technical training in Germany. He then began practical work as assistant engineer to the Eschweiler Mining & Smelting Co. While in their employ, in 1864, he was sent to the island of Sardinia to open up some large zinc mines and establish concentrating plants. From there he went to the Atlas mountains in Tunis for the same purpose. In 1856 he became designing and constructing engineer for the firm of J. C. Harkort, of Haspe, in Westphalia, who were then the largest iron bridge builders in Europe. In 1868 he went back to the Eschweiler company, who had affiliations with the Corphalie Zinc Co., of Belgium, and at once became chief engineer of the latter firm, staying with them till 1872. In the fall of 1870 he first came to the United States, and spent two years in studying the lead and zinc deposits of this country for the Corphalie Co. He then went into practice for himself, becoming identified with the zinc industry of the country. In 1876 he became consulting engineer for the Coleraine Coal & Iron Co. and the Tamaqua Machine Works, and in 1875 General Manager of the Lynchburg Iron Co. Later he was connected with the Haile Gold Mine in South Carolina, and for several years was its general manager, at the same time continuing general practice as a consulting engineer. In 1887 he was appointed Managing Director of the Trenton Iron Co., which position he held until the end of 1896. During the last ten years he has also been interested in phosphate mining in Florida, and in the sulphur mining operations in Louisiana. As managing director of the Trenton Iron Co. he made a specialty of the development of the best systems of aerial transportation by means of wire cables, and brought the Bleichert system to a high degree of perfection. Upon retiring from the Trenton Iron Co. he resumed his practice as consulting engineer, with headquarters in New York. Mr. Spilsbury is also a Member of the American Society of Civil Engineers, and of the American Society of Mechanical Engineers.

Mr. Clement Acton Griscom, who has been the President of the Society of Naval Architects and Marine Engineers since its organization in 1893, was born in Philadelphia on March 15, 1841. His paternal ancestor, Andrew Griscom, came from England in 1680, and was an associate of William Penn, and on the maternal side he is descended from Thomas Lloyd, Deputy Governor and President of the Council of the Province of Pennsylvania in 1684-93. Mr. Griscom is a son of the late Dr. John D. Griscom, a prominent physician of Philadelphia, and of Margaret Acton, of Salem, N. J.

After attending the public and private schools of Philadelphia, he closed his educational course, at the age of 16 years, at the Friends' Academy of that city. In 1857 he became a clerk in the famous house of Peter Wright & Sons, shipping merchants, and he made such rapid progress that in 1863 he was admitted to membership in the firm. To qualify himself for his duties, which required him to take almost the entire control of the shipping and steamship business of this well-known Philadelphia firm, Mr. Griscom studied marine architecture as applied to the commercial fleet, and attained a broad knowledge of this subject. He was one of the first in this country to recognize the growing ascendency of steam over sails for commercial purposes.

In 1871, when the International Navigation Co. was organized by the firm of Peter Wright & Sons, Mr. Griscom was made its Vice-President. He was elected President in 1888, upon the retirement of James A. Wright, and has since held that responsible position. This company then owned not only the four steamers of the old American Line, but nearly all the capital stock of the Belgium corporation known as the Red Star Line, which operates ten large steamers in the trade to Antwerp. In 1886 the International Company also bought out the old Inman Line, then running to Liverpool, and built the steamships "New York" and "Paris," which were later followed by the "St. Louis" and "St. Paul," after Congress, largely through the efforts of Mr. Griscom, by special legislation, enabled the vessels of this line to fly the American flag. His personal labors in this direction were warmly recognized by the press generally and by formal resolutions of the Union League Club, of Philadelphia, which tendered him a complimentary banquet on April 18, 1893.

In addition to his duties as the President of the International Steamship Co., Mr. Griscom is a Director of the Pennsylvania R. R. Co., the Bank of North America, the Fidelity Trust & Safe Deposit Co., the Western Saving Fund Society; the Insurance Company of North America, and the Mercantile Trust Company, of New York. He was one of the organizers of the National Transit Co., and was its President for several years after its organization.

Mr. Griscom is one of the best types of the successful American business man. He is energetic and aggressive, with large executive abilities and remarkable foresight. Personally, his genial manner has won for him a wide circle of friends.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Town Liable, Though Water Supply Inadequate.

Even though an attempted rescission by a town of a contract for water were effective, still the water company, having continued to supply water, though less than the contract quantity, and the servants and employees of the town having continued to use it, the town would be responsible.—U. S. Waterworks Co. v. Borough of Dubois (Supr. Ct. Penna.), 35 Atl. Rep., 251.

Bridge Building—Negligence.

An agent in charge of the repairing of a bridge, who with notice of the danger authorized iron pillars to be rolled on rollers resting on pieces of timber stretched over the cross beams before the floor was laid, was liable to an employee as to whom he was a vice principal, and who had no notice of danger, for injuries sustained by one of the rollers slipping out, and falling through the cross beams upon him while working underneath.—Kenney v. Lane (Ct. Civ. App. Tex.), 36 S. W. Rep., 1063.

Limitation of Recovery on City Contracts.

In an action against a city, based on contracts for the excavation of stone, which provided that the work should be done in accordance with cross sections and specifications of the city engineer, no recovery can be had for excavation outside of the area so designated by the engineer.—McEwen v. Nashville, 36 Sown. Rep., 968.

City Must Keep Sewers in Repair or Pay Damages.

Where a city has exercised its statutory authority to construct a sewer, it must keep it in proper repair, even though it was properly constructed in the first place; and where it has notice of its condition, or by the use of reasonable diligence could have known it, the city is liable for damages to adjacent property owners, where the condition of the sewer has become a nuisance.—Lindsay v. City of Sherman (Ct. Civ. App., ex.), 36 S. W. Rep., 1013.

Contract to Supply Water for Fire Protection.

It is the duty of a city to furnish protection to the property of its citizens against fire, and a water company which contracts with the city to supply water for that purpose, through hydrants supplied by the city and attached to its mains, becomes a municipal agency; and it cannot summarily shut off the water from such hydrants without other provision being made for protection against fire, and the courts will enjoin such act, though justifiable under strict construction of its contract with the city.—Bienville Water Supply Co. v. Mobile (Sup. Ct. Ala.), 20 So. Rep., 742.

Paving Contract in Pennsylvania.

Under the laws of Pennsylvania, providing that every contract involving an appropriation by municipalities of

money shall designate the item of appropriation on which it is founded, and the estimated amount of expenditure thereunder shall be charged against such item, and so "certified by the controller on the contract before it shall take effect as a contract," failure of a contract by a city with a street paving company to certify that the controller has charged the amount of expenditure for the paving against the appropriation made for its payment renders the contract inoperative, and prevents recovery against adjacent property owners for work done under it.—City of Erie v. Land on 18th St. (Sup. Ct. Penna.), 35 Atl. Rep., 136.

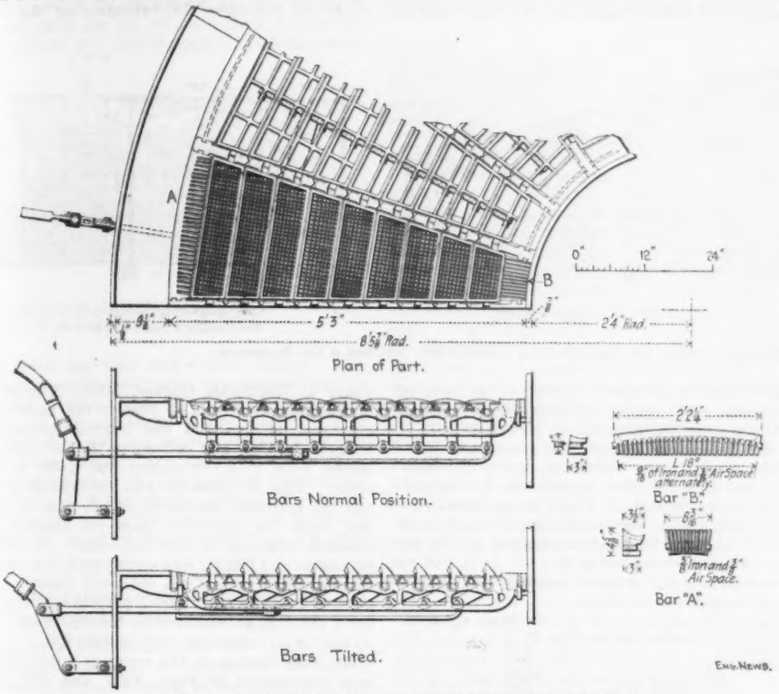


FIG. 1.—SHAKING GRATE WITH WIRE SCREEN SURFACE.
Designed by G. C. St. John, for the New York Steam Co.

WIRE-SCREEN SHAKING GRATE FOR BOILER FURNACES.

We illustrate herewith a novel form of grate bar and shaking grate which has been designed and patented by Mr. G. C. St. John, Vice-President of the New York Steam Co., 2 Cortlandt St., New York, and which has been used successfully for eleven months in the power-house of that company in Greenwich St. The peculiar feature of this grate is that the greater portion of its surface is composed of a wire netting, of a square mesh, made of wire about 0.06-in. diameter and ⅝-in. square spaces, giving a larger air space in proportion to the whole surface than is possible with cast-iron grates. Fig. 1 shows a plan view of a portion of a grate designed for a 1,000-HP. Climax boiler. The boiler is a vertical water-tube boiler with its grate surface of circular shape. The grate is therefore conveniently divided into a number of sectors, one of which is shown in Fig. 1. Each sector is composed of a number of movable parts which are operated by the ordinary shaking grate apparatus in the usual manner. One of the views in Fig. 1 shows an end view of the grate in its normal position, and another shows the movable parts shifted to their extreme position for dropping ashes. Fig. 2 shows the details of one of the sections.

Two of these grates have been used in the steam company's station under Babcock & Wilcox boilers since February last, another in the same station under the Edgar vertical fire-tube boiler, for about four months, all of them using anthracite buckwheat coal. A third has been used for three months in Lorillard's tobacco factory in Jersey City, and a fourth has just been put under a 1,000-HP. Climax boiler, at the uptown station of the New York Steam Co., at foot of 60th St., East River. The Edgar boiler which is rated at 1,000 HP. has a grate surface of about 80 sq. ft., and a chimney 5 ft. 6 ins. diameter and 160 ft. high. With the strong draft produced by this chimney and with the large air spaces of the grate, it has been found possible to burn from 38 to 40 lbs. of buckwheat coal per square foot of grate per hour. With a very poor quality of semi-bituminous coal, containing 30% of ash, over 42 lbs. per square foot per hour has been burned. We give below the results of some recent tests which are instructive in showing how detrimental a high per centage of ash is both to the capacity and the economy of the boiler. The last test was with the poor semi-bituminous coal already mentioned, the others were with buckwheat anthracite. The test of Oct. 5 was made with a coal unusually low in ash, with the result that the horse-power developed was above the rating and the economy was the best reached in the series of tests.

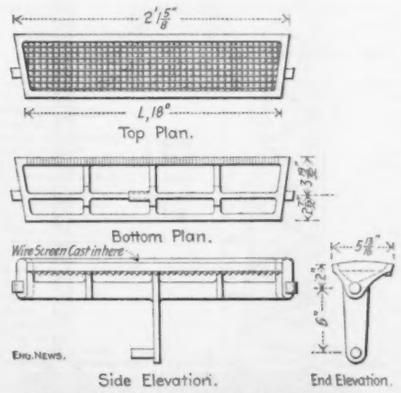


Fig. 2.—Details of Movable Portion of Grate.

Date of Test.	Sept. 29.	Oct. 5.	Oct. 8.	Oct. 20.	Oct. 22
Duration, hours	5¾	6½	5½	7	1¾
Lbs. coal, per sq. ft. grate, per hr.	38	37⅞	38.9	39.5	42.6
HP. developed	931	1,039	721	755	620
Per cent. ash	..	10.42	23	25	30
Evaporation per lb. of combustible from and at 212°, lbs.	9.82	11.04	7.68	8.02	6.06

The grate surface being chiefly of wire netting it might be supposed it would easily be burned out, but on the contrary, it appears to be very durable. The rapid current of air passing through it, together with the layer of ash, which usually rests upon it seem to keep it cool and prevent its burning out.

THE ORIGIN OF CEREMONIES CONNECTED WITH THE LAYING OF THE CORNER-STONE OF A STRUCTURE.

A correspondent of "Le Genie Civil," induced by the late ceremonies attending the laying of the corner-stone of the bridge of Alexander III., in Paris, by the present Czar of Russia, has been investigating the origin of similar observances. In this case the stone contained a full account of the ceremony and a set of coin of the current year. It is scarcely necessary to remark that the deposit of these objects in a stone that is supposed to be forever buried under the pier of a bridge is simply a tribute paid to ancient usage.

The performance of certain rites at the beginning of an important work is a universal custom, having its origin in the remotest past. It can be traced through all nations and times and in all religions, and it is generally supposed to indicate the need of placing these structures under the protection of some one or more of the gods, and in the belief that in this manner a happy influence may be exerted upon the strength and duration of the edifice. The offering of money was among some people accompanied by sacrifices, and M. Sebillot, in an interesting volume on the different superstitions relating to public works, cites numerous cases in which human victims were buried alive in the foundations to propitiate some controlling deity. Bridges in particular were the objects of important ceremony and cruel sacrifices from the earliest period. It was looked upon as somewhat presumptuous to obstruct the free course of a river by placing in it the piers of a bridge; and the Greeks regarded as a sacrilege the bridging of the Hellespont by Xerxes.

In Old Rome it was commonly believed that the Tiber would submit to but one bridge, that of Sublicius, made famous by the exploit of Horatius Cocles; and the use of iron upon any such structure was forbidden altogether, as it was a metal which was regarded as profaning sacred places. When it became necessary to repair a bridge all manner of ceremonies were conducted upon the bridge itself and upon the two banks of the river, and these ceremonies were presided over by the "pontifex," or maker of bridges. In Greece, bridges were originally built according to an architectural ritual and by men having a sacerdotal character. In the Middle Ages a religious order existed in Europe known as the "Freres Pontifes," or Bridge Brothers, which spread over Provence and Languedoc. Among the structures ascribed to the work of this brotherhood is the bridge of Saint-Esprit, over the Rhone, built between 1265 and 1309. It has 26 arches in a total length of 2,421 ft., and is still in use.

The devil, however, is the most commonly accredited architect of the older bridges, and scarcely a department in France is without its "Pont du Diable." According to the ancient traditions, this demon was always ready to contribute his services as bridge architect, provided that he was paid a certain salary, usually the first living creature crossing the finished bridge. When the structure was completed, says tradition, it was customary to drive over a cat, in advance of any human being; and under the assumption that the demon would be enraged at this trickery and destroy the work in revenge, the services of a priest were called in and the structure rendered invulnerable to further attacks by its builder by a plenteous use of holy water.

The legends connected with the encasing of human beings in some part of the bridge as a propitiary sacrifice, are less numerous than those ascribing the work to the devil. But, on the other hand, the belief that the sacrifice of human life is still practiced on such occasions existed at a recent date among some of the lower and more ignorant classes in Middle Europe. In 1829, in connection with the building of the Kerventhal bridge, in Lower Saxony, the popular belief was that an infant was buried in one of the piers; and in 1843, during the construction of a new bridge at Halle, Germany, the report was spread abroad among the people that a child was being sought for for this purpose. In the same country, when the iron railway bridge was built across the Goelsch, the peasants affirmed that a child had been buried under the foundation. Similar reports were once current in Great Britain, and Lord Leigh was ac-

cused of having buried one of his retainers in the foundation of a bridge at Stoneleigh.

According to Sebillot, the practice of making human sacrifices disappeared from Europe a very long time ago; but their memory still survived in a one-time custom of sprinkling with the blood of some animal the first stone laid in the structure; or in the custom of burying in the foundation some man recently put to death. An old Scotch proverb expresses this belief, as follows:

"If you wish this bridge to resist a flood,
Place the foundation between water and blood."

In 1872, when the Dedoga Tchengitch of Herzegovina laid the foundation for a bridge, he sacrificed upon each main stone of the foundation a black sheep, and under each corner-stone he placed a ducat. In some cases wine was buried in the foundation and this liquid was also used to sprinkle the key of the arch. In this connection it may be said that the rites celebrating the founding of a bridge have passed through an evolution analogous to the rites preceding the launching of a ship. Among the Carthagenians, and in our day among certain Polynesian tribes, these latter ceremonies were often made the occasion for human sacrifice; but now, this antique rite has, in both cases, been replaced by a ceremonial sprinkling of wine.

Though these rites have lost much of their force, they are far from being abandoned, especially among masons. For example, when the Minister of Public Works was laying the corner-stone of the bridge of Conflans, over the Seine, and was simply placing in the box a description of the work, some one remarked that he had forgotten to deposit any money with it, according to ancient usage; as a consequence, the ceremony was suspended until coin minted in the current year could be procured.

THE MACHINERY HALL AT THE SWISS EXPOSITION AT GENEVA.

The machinery hall for the Swiss Exposition of 1896 is 490.4 ft. long and 288.6 ft. wide. But with the object of reducing to the least possible cost the unit of area roofed over, the committee on construction decided to use a cantilever system of roof trusses, with three spans; the type being suggested by the Mines and Mining Building at the Chicago Exposition (see Engineering News, May 5, 1892). The plan here shown from "Le Genie Civil" was designed by Thomas Bell & Co., of Kriens, and it is chiefly remarkable for its economy in construction and its lightness.

Each complete roof truss is made of two independent cantilevers, each hinged to the top of a metallic column and provided with anchor columns at the ends. This system, while very light in appearance, had the advantage of rendering the distribution of stresses in the different members almost completely independent of changes in temperature and any ordinary settlement in the foundations. The entire area was covered by 12 beams, spaced 47.56 ft. apart, except for the two trusses nearest to the ends, which were spaced 31.16 ft. from the end. The lantern surmounting the building was 428 ft. long and 26.24 ft. wide. The general dimensions of the structure the elevation of the longitudinal system and the general method of erection are shown in Figs. 1, 2 and 3.

In a structure so tall and light the lateral effort due to wind pressure and the slight settlement which might occur in the foundations had to be especially considered. There were no means of providing an interior support against a lateral effort in a structure of this character, and consequently the builders anchored the outer end of the half-beam to a riveted column in the form of a pyramid, tied down by four bolts passing through a mass of masonry, as shown in Fig. 4. The two halves of the roof are practically independent except in the end spans, where the half-beams are firmly riveted together on the centerline, as shown in Fig. 2. Light longitudinal riveted trusses, 4.6 ft. high, connect the outer posts together; and the longitudinal system at the interior posts is shown in Fig. 3.

In calculating the weights imposed the following unit weights were taken:

Snow load, 1 ft. deep	6.15 lbs. per sq. ft.
Wind pressure (80 kilos per sq. m.)	16.40 " " " "
Iron members	6.15 " " " "
Covering in zinc	5.95 " " " "
" " glass	4.92 " " " "
" " corrugated zinc	3.07 " " " "

Each half-beam weighed about 12,540 lbs. Each outer column weighed 3,707 lbs., and each interior column weighed 3,014 lbs. The weight of the lantern, which was 26.24 ft. wide, was only 65.6 lbs. per lineal foot. The price of the entire structure, with the contractor permitted to take possession of the material at the end of the exposition, was about 81 cts. per square foot. With material included the cost is given as about $1 per square foot. The method of erection is clearly shown in the Figs. 2 and 3.

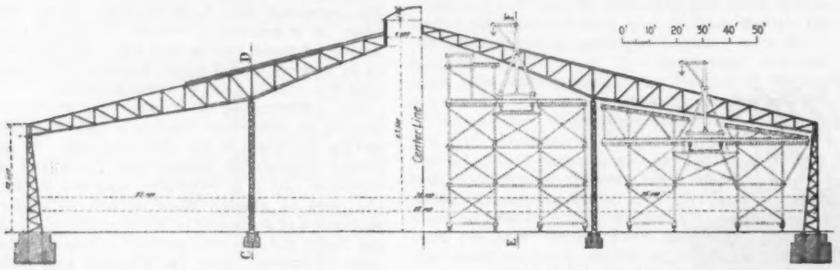


Fig. 1. Ordinary Half Truss.

Fig. 2. Half Truss at End of Building.

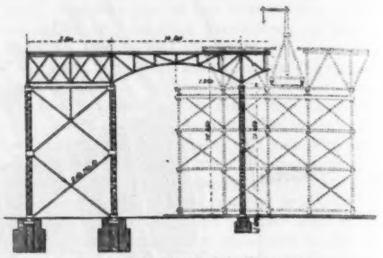
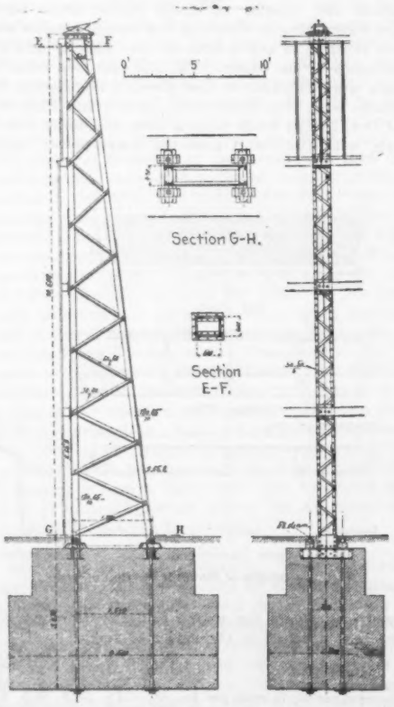


Fig. 3. Longitudinal Section on C-D and Section of Scaffolding on E-F.

ROOF TRUSSES FOR THE MACHINERY HALL AT THE GENEVA EXPOSITION. Th. Bell & Co., Engineers.



Details of Columns Supporting Outer End of Trusses

THE IMPROVEMENT OF MARQUETTE HARBOR, MICH.

In the annual report of the Chief of Engineers for 1896, Major Clinton B. Sears, Engineer Corps, U. S. A., describes the extension of the breakwater at Marquette Harbor, Mich. The purpose of this breakwater is to protect the harbor from northeast storms and the original project was adopted in 1868 and called for timber cribs, ballasted with rock, extending out 2,000 ft. from shore. This breakwater was completed in 1875, but the increased shipment of ore from this port has made the protected area too small for the shipping engaged in this commerce. In 1888 an extension of 1,000 ft. was authorized, but the timber superstructure of the old work began to show general decay, and in 1890 a project was approved for a concrete superstructure for the whole breakwater, at an estimated cost of $232,936.

The construction of the concrete superstructure was commenced in June, 1895, and 470 lin. ft. were built before storms stopped the work. The cross-section of this work, designed by Major Sears, differed from established practice here and abroad, in presenting 45° slopes to the waves; the intention being to lessen the shock by allowing the waves to slide over the top without impact and fall onto a cushion of water inside, where they produced no disturbance. The 470 ft. built has gone through several unusually hard storms and a very trying winter and has met all expectations.

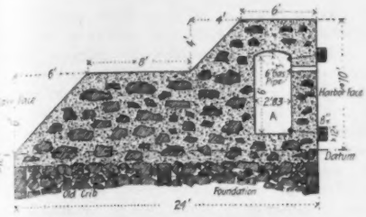
The detail of this concrete construction is described by Mr. Clarence Coleman, Assistant Engineer. The cribwork of the original structure was cut down to 1 ft. below the low-water datum of Lake Superior, and upon this was built the monolithic concrete superstructure, shown in the cut. This superstructure presented two 45° slopes on the lake side, with the general dimensions shown on the cut. On the harbor side is a vertical wall with a gallery, 2.83 ft. wide and 6.25 ft. high, molded throughout the entire length. At intervals of 100 ft. 6-in. wrought-iron pipe are built into this wall as ventilators. The harbor face is protected by two 8×12-in. timbers secured by 33×¾-in. bolts, which pass through sleeves built into the concrete made of ¾-in. gas-pipe.

It was determined to build the concrete work in two parts. Upon the rubble stone in the cribs a carpet of 8-oz. burlap was first laid, and upon this was deposited a subaqueous foundation of Portland cement concrete extending to low-water mark. Upon the latter was to be placed a series of monoliths molded in place and with a 10-ft. length for each block. Blocks were first built spaced exactly 10 ft. apart, and the intermediate blocks were molded later.

The Medusa brand of Portland cement, manufactured by the Portland Cement Co., of Sandusky, Ohio, was used in the subaqueous foundations. This cement cost $2.20 per barrel delivered at the work; the lake sand cost 50 cts. per cu. yd. delivered, and the broken trap and quartzite rock cost $1.58 per cu. yd. in the bins. The proportions of the concrete were 1 cement, 2½ sand and 5 stone, and the cost per cu. yd. deposited was $6.35, including the cost of loading the scow.

In making the monolithic blocks the Keystone brand of natural cement was employed, as manu-

factured by the Milwaukee Cement Co., of Milwaukee, and delivered in the warehouse on the work for $1.04 per barrel. A volume of 9 cu. yds. of rubble stone was built into the heart of each of the standard blocks, amounting to 27% of the total volume of the monoliths. The concrete used cost $3.64 per cu. yd. as mixed; and the standard block cost $4.72 per cu. yd., including in this the cost of moving and setting forms, handling stone,



Cross-Section of Concrete Superstructure for the Breakwater at Marquette, Mich.

anchor bolts, gas-pipe and timber-waling. The continuous gallery built into the harbor face is intended to permit access at all times to the harbor light at the extremity of the pier, which is now sometimes put out during storms at times when it is inaccessible from the pier or by boats.

Observations made on this concrete superstructure during last winter show no signs of abrasion on the faces of the slopes from ice, and there are no cracks or signs of disintegration in the concrete.

TESTS OF AN EXPERIMENTAL TURRET OF THE U. S BATTLESHIP "MASSACHUSETTS."

During May and June, 1896, the U. S. Naval Department undertook to practically determine the question of the strength of the present turret construction of U. S. battleships by submitting an experimental turret to an actual firing test at Indian Head. The methods and results of this test are given in a paper, which was presented at the fourth meeting of the Society of Naval Architects and Marine Engineers, by Commodore W. T. Sampson, U. S. N., Chief of the Bureau of Ordnance. For the full details and illustrations showing the results of this test, our readers are referred to that paper, as our space permits only the following abstract:

The turrets for the 13-in. guns of battleships of the "Massachusetts" and "Indiana" type are cylindrical steel structures, weighing about 450 tons and resting upon flanged steel rollers traveling on a circular track mounted upon a foundation forming a part of the framework of the ship. These turrets are turned by spur-wheel gearing, working in a rack secured to the inner circumference of the upper roller path. The tests made were especially intended to prove the ability of the turret to resist deformation from shock, as it is scarcely necessary to say that any permanent deformation might so jam the turret as to prevent turning or throw out of line the slides of the guns, or otherwise disable both guns and turret.

The experimental turret was made to conform as nearly as possible in its details to the design of the turret of the "Massachusetts." It was 10 ft. 10½ ins. high inside and 27 ft. 3 ins. inside diameter, with 32 vertical angle frames, steel roof and floor, gun-girders, etc. The armor was represented by one Harveyized nickel steel ballistic plate, 15 ins. thick, to receive the impact of the shot, and ten cast-iron plates of the same thickness. The weight of the two 13-in. guns and their mounts was represented by 180 tons of pig iron symmetrically distributed about the turret floor and upon the gun-girders, shored to prevent movement. The whole experimental turret weighed 450 tons, including the pig iron and the 148 tons of 15-in. cast-iron plates. A foundation was provided by driving 128 14-in. piles in a 30-ft. square, and then capping these piles by 12×12-in. Georgia pine sticks laid 12 ins. apart. Over the caps was a close-laid floor of 12×12-in. pine, covered by 3 and 4-in. wrought iron plates on the circle of the turret. The turret rested on 20 cylindrical steel rollers, each 30 ins. long by 12 ins. in diameter, chocked with wrought-iron wedges to prevent rolling.

At this turret one test round was fired from a 10-in. breech-loading rifle, at a range of about 360 ft., and two rounds from a 12-in. rifle. The elements of the three rounds are given as follows:

	Rounds 1.	2.	3.
Gun used	10-in.	12-in.	12-in.
Weight of powder, lbs.	178.6	355.6	440.5
Weight of projectile, lbs.	500	850	850
Distance to target, ft.	362	359	359
Striking velocity, ft.-sec.	1,683	1,701	2,000
Striking energy, ft.-tons	9,829	17,069	23,626
Striking energy per ton of turret, ft.-tons.	21.84	37.95	52.5

Wheeler-Sterling armor piercing projectiles were used in the rounds 1 and 2, and in the third round a Johnson fluid compressed cast-steel armor-piercing shot was employed, fitted with a soft steel cap weighing 17 lbs. The first 10-in. shot smashed upon the plate after penetrating 9½ ins.; the second, a 12-in. projectile, penetrated 11½ ins. and then broke up, with the head welded to the plate. The Johnson shot, with the heavier powder charge and striking energy, penetrated the plate but broke up in passing through, wrecking the rear part of the turret over an area of 4 ft. square. As a general result, armor bolts were broken and driven to the rear in the immediate vicinity of the shots, the mantled plating was pierced, the oak backing wrecked and splintered and the turret was forced to the rear over its rollers 7 and 9 ins. in the two last shots. But no deformation of the turret as a whole could be discovered, and the result of the firing leaves no room for doubt as to the fact that the turret framing possessed ample strength to withstand the maximum strains which can be put upon it by the impact of any projectile.

But the question of the strength of the rollers and the roller path, or the resistance against displacement of the turret as a whole was not, at first sight, so well established. Owing to the difficulty of fixing upon a proper mean value for the coefficient of friction, and especially upon the unknown duration of the impulse which communicates the energy, it was impossible to arrive at even an approximate determination of the amount of energy actually imparted to the turret as a whole. Much of the energy of the projectile is expended in penetrating, cracking, tearing and heating the armor plate met, and in distorting and bending the frame; what is left can alone impart motion to the whole turret. Careful, special experiments were made to determine, if possible, how much energy was expended upon the turret framing and how much is converted into movement of translation of the turret as a whole.

In these tests the maximum movement of the experimental turret on its rollers was 9½ ins. But it must be remembered that this turret was free to slide upon rollers, themselves immovable, while in the actual turret the rollers resist this movement by their flanges, with 150 sq. ins. of metal opposed to horizontal movement, or a sufficient area to safely resist a load of 750 tons. Moreover, when the turret mounted on the ship is struck, any energy forcing the turret against the roller path is met by the elasticity of this path and of the turret and of the whole framework of the ship, and the ship itself heels slightly until the increasing resistance encountered balances the force of motion and brings the structure to a rest. Further, when one of the 13-in. guns in the actual turret on board ship is fired, a pressure of 350,000 lbs. is developed in the recoil-cylinder, acting over a distance of 50 ins. In other words, the recoil of a 13-in. gun develops an energy of about 650 ft.-tons, which acts as a dead pull on the turret framework. Such a pull exerted upon the experimental turret, with its immovable base, would slide it 3 ft., even assuming a coefficient of friction of 0.5; whereas the actual impact only moved it 9½ ins. It is assumed, therefore, that a turret which will stand the recoil of a 13-in. gun will certainly withstand, without injury, the strains of impact from any projectile. Commodore Sampson then says that the turret as designed will adequately perform all its functions; holding in place the armor shield of the guns and retaining its general form intact, even when locally wrecked by the energy of an impinging shot.

ANOTHER METRIC CONVERSION TABLE.

Referring to the conversion table of Mr. Hunt, published in our issue of Dec. 17, Mr. David Molitor, of the U. S. Engineers' Office, at Detroit, Mich., says that while this table will answer very well for ordinary comparisons between the metric and U. S. systems, the constants are not carried out to a sufficient number of decimal places to give accuracy where large numbers are involved. He therefore sends us the accompanying table compiled by himself about two years ago from the best data available at that time. He also calls attention to an error in our reprint of Mr. Hunt's table, in the tenth line from the bottom, where the constant 0.026 should be 0.062:

Metric Conversion Table, Compiled by David Molitor.

Units compared.					Logarithm of factor.	Reciprocal of factor.	Log. rec. of factor.
Centimeters	×	0.39370432	=	inches.	−1.5951701	2.5390775	0.4048208
Meters[1]	×	3.2808693	=	feet.	0.5150889	0.3047973	−1.4840111
Kilometers	×	0.6213767	=	miles	−1.7933550	1.6093296	0.2066450
Square centimeters	×	0.15500304	=	square inches	−1.1903402	6.4514855	0.8096598
Square meters	×	10.7641017	=	square feet	1.0319778	0.0929014	−2.9680222
Square kilometers	×	247.10983	=	acres.	2.3928900	0.004046784	−3.6071100
Cubic centimeters	×	0.061023352	=	cubic inches	−2.7855103	16.3866302	1.2144897
Cubic meters	×	35.3156098	=	cubic feet	1.5479667	0.02831600	−2.4520333
Cubic meters	×	264.179025	=	U. S. gallons	2.4218983	0.00378531	−3.5781017
Liters	×	61.02535	=	cubic inches	1.7855103	0.01638663	−2.2144897
Liters	×	33.814915	=	fluid ounces	1.5291083	0.02957274	−2.4708917
Liters	×	0.26417902	=	U. S. gallons	−1.4218983	3.7853122	0.5781017
Liters	×	0.02837835	=	U. S. bushels	−2.4529871	35.2381301	1.5470129
Grams	×	15.432356	=	grains Troy or Ap.	1.1884326	0.06479887	−2.8115674
Grams	×	0.0338149	=	fluid ounces.	−2.5291083	29.572748	1.4708917
Grams	×	0.03527395	=	Avoirdupois ounces	−2.5474541	28.349532	1.4525459
Grams	×	0.03215073	=	Troy ounces	−2.5071908	31.103490	1.4928092
Kilograms[2]	×	2.20462234	=	Avoirdupois pounds	0.3433341	0.45359253	−1.6566959
Kilograms	×	2.6792278	=	Troy pounds	0.4280096	0.3732419	−1.5719904
Kilograms	×	0.0011023011	=	tons (2,000 lbs.)	−3.0423041	907.1850	2.9576959
Kilograms per lin. meter	×	0.6719628	=	lbs. avoird. per ft.	−1.8273452	1.4881777	0.1726548
Kilograms per sq. centimeter.	×	14.223088	=	lbs. per square inch	1.1529039	0.0703083	−2.8470061
Kilograms per square meter	×	0.2048124	=	lbs. per square foot	−1.3113563	4.8825159	0.6886437
Kilograms per cubic centimeter.	×	36.126325	=	lbs. per cubic inch.	1.5578238	0.027680707	−2.4421762
Kilograms per cubic meter	×	0.06242627	=	lbs. per cubic foot.	−2.7953674	16.018897	1.2046326
Kilogram-centimeters	×	0.8679690	=	inch-pounds	−1.9385042	1.1521140	0.0614958
Kilogram-meters	×	7.2330750	=	foot-pounds	0.8593230	0.1382538	−1.1406770
Metric HP.	×	0.9863189	=	HP. in ft.-lbs. sec.	−1.9940173	1.01387103	0.0059827
Moment of inertia, centimeters	×	0.0240259	=	M. of inertia, ins.	−2.3806804	41.621683	1.6193196
Metric units of heat	×	3.96832	=	English heat units.	0.5986067	0.2519058	−1.4013933
Metric atmospheres	×	1.0546234	=	English atmos.	0.0230974	0.9482058	−1.9769026

[1]The value of the meter is derived from the value of the yard determined by Clarke, and published in the Coast and Geodetic Survey Report of 1884.

[2]The value of the kilogram is taken from the Coast and Geodetic Survey Report of 1893.

1 liter water at 4° C. weighs 1 kilogram, and has a volume of 1 cubic decimeter = 1,000 cubic centimeters.
1 cubic centimeter water at 4° C. weighs 1 gram.
1 U. S. or Winchester gallon = 231 cubic inches.
1 Imperial gallon = 277.2738 cubic inches (Roscoe).
1 U. S. bushel = 2,150.42 cubic inches.
1 pound Troy = 1 pound Apoth. = 5,760 grains Troy.
1 ounce Troy = 1 ounce Apoth. = 480 grains Troy.
1 pound Avoirdupois = 7,000 grains Troy.
1 ounce (fluid) = 1-128th U. S. gallons = 455.7 grains Troy at 60° F. = 1.80469 cubic inches at 60° F.
1 ounce Avoirdupois = 437.5 grains Troy.
1 pint = 16 fluid ounces.
1 metric HP. = 75 kilograms per second.
1 English HP. = 33,000 foot-pounds per minute = 550 foot-pounds per second.
1 metric atmosphere = 1 kilogram per square centimeter = 73.55 centimeters, or 28.958 inches of mercury.
Degrees Fahrenheit = (degrees Centigrade × 1.8) + 32.
Acceleration of gravity at Paris = 980.94 centimeters per second = 32.18336 feet per second.

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In the discussion of the question whether the various municipalities about the harbor of New York should be consolidated into one, there has been presented but one valid argument in favor of such a union. The idea that such a colossal change should be made merely to make a city which should outrank all others on the continent in population is too childish to deserve a moment's consideration. The claim that such a consolidation would benefit one or the other of the great political parties, is by far too trivial to justify a change of such magnitude, which would so vitally affect a population of over three millions. Moreover, it would take a wiser set of political managers than those that now rule the destinies of New York to foretell what the political results of the consolidation would be anyway, in these days when party ties hang ever more and more loosely. The one valid argument for effecting such a consolidation is that it would afford an opportunity for wiping out the many anomalies that exist in the present municipal charters, and the Greater New York could begin its existence under a charter which would better secure public rights and public property, and make more easy the task of economically governing the great city.

The legislature of New York a year ago placed the work of drafting a charter for the consolidated city in the hands of a commission, with instructions to report a completed charter for adoption by the legislature now in session. That commission has now completed its work, or, more accurately, has reached the limit of time allotted to it by the legislature and will present the charter, therefore, in such shape as hurried preparation by a committee of the commission, hurried review by the other members and hurried criticism at a few brief public hearings has permitted.

As a matter of fact, for the most part, the charter is understood to be the work of a single member of the commission. The work of the other members has been a more or less hasty review of the draft which he made. There has been absolutely no time for a thorough examination of the charter by the press or the public; but the few public hearings that were held showed that there are many respects in which the charter could be improved, and many changes were in fact made by the commission as a result of these hearings.

This charter now goes to the legislature, and expert as the members of that body may be in the science of civil government, it is safe to say that not one of them can take the time to study through the charter from beginning to end, and form an intelligent judgment upon the thousand and one matters of which it treats. If, then, the legislature sees fit to enact this charter as a law at its present session, we shall have the spectacle of a community of over three millions of people obliged to establish a government under an organic law, prepared in practically all its details by a single man, and reflecting a single man's ideas upon the science of city government. How and why should it be expected that the government of a city under such a charter would be any better than that of the various municipalities as now constituted? Experience has shown that, other things being equal, large cities are worse governed than small ones. There is no inherent virtue in consolidation that can offset any errors or omissions which the new charter may contain; rather the reverse will be true.

Under these circumstances, it is earnestly to be hoped that the legislature may heed the expression of public opinion that is now so strongly manifested, and grant an extension of time for the consideration of this subject. We have every reason to believe that the Charter Commission has labored honestly and faithfully to prepare a charter that will conduce to better government, and has done the best it could in the time allotted to it. In some features its draft is especially worth commendation; for example, its provision that the limit of municipal franchises should be 25 years. But in some other respects the charter which it has prepared certainly needs a careful consideration before its adoption could be advised. We remarked at the outset that there was little reason why the Greater New York scheme should be favored anyway; if, however, the politicians are determined to bring it about, they ought at least to have the grace to permit it to be effected with sufficient deliberation that the evil results may be lessened and the benefits, if such there be, may be fully realized.

In his last annual report, Gen. W. P. Craighill, Chief of Engineers, U. S. A., says that experience has shown that the system recently adopted of providing funds for the carrying on continuously, or for the completion of certain public works, has resulted in materially reducing the cost of such works, and it has also benefited commerce by providing increased facilities within reasonable periods of time. He further says that if this system is restricted to improvements fully justified by the interests of commerce, and provided that appropriations are so made as to avoid delay in payments to contractors, it will prove a wise and economical system. The act of 1896, however, extends the payment for such works over several years, and what effect this provision will have upon contract prices remains to be seen.

The change in system referred to is doubtless a change in the right direction, and it is a vast improvement upon the old method of granting limited appropriations at irregular intervals and meanwhile heavily taxing the government for ordinary maintenance during the periods of cessation from active work. But that money may be available for improvements proposed in the true interests of commerce in any section, the restriction of appropriations to works of this character, as suggested by General Craighill, is quite as essential to the economic success of the new system as the method of full appropriations. To illustrate what we mean, we will take the last report of Maj. Clinton B. Sears, Corps of Engineers, U. S. A., in which he comments upon the construction of a harbor of refuge at Presque Isle, in Marquette Bay, Mich. This new work was ordered by Act of Congress of June 3, 1896, and the improvement contemplated includes a breakwater 1,000 ft. long, costing about $50,000. Major Sears says that why a harbor of refuge should be constructed in this bay is entirely unknown to his office, as there is already an ample and safe refuge of this character at Marquette harbor, only 1½ miles to the south. He finds, however, that a railway company has been recently organized for the shipment of ore from the iron mines near Ishpeming, Mich., and this company has its terminus near the site of the proposed harbor and is now building two docks for handling ore and for commercial purposes. He presumes, therefore, as the only explanation of the new government work, that the promoters of this appropriation desire to protect these docks from northeast storms.

As Major Sears says there is no public necessity whatever for a harbor of refuge at this point, we must assume that the government is here spending money for a purely private enterprise, and is doing work that should be done by individuals. This is, unfortunately, but one of many similar cases where Congress listens to the promoters who are seeking to further the interests of some particular locality instead of to the unprejudiced advice of the government engineer. It is worth consideration whether our present system under which Congress has the sole power to say what public improvements shall be carried on is not radically wrong. It is the province, undoubtedly, of Congress to fix the aggregate amount of money which shall be expended each year upon any class of public improvements; but the Executive branch of the government, through its engineers, should have the power of apportioning this expenditure to the various works, and deciding upon what is and is not fully justified by the demands of commerce and the best interests of the country as a whole. This harbor at Presque Isle is the direct result of individual influence brought to bear upon some Congressman, and by this Congressman upon his fellow-members in return for like favors. The scheme certainly did not emanate from the office of the engineer who is most familiar with the general needs of that part of Lake Michigan.

It is really absurd when one clearly understands it, that an assemblage of men at Washington, most of them lawyers or politicians, should have the responsibility of deciding just how much money should be spent on every river and harbor, every postoffice and custom house, and every piece of public work from the greatest to the least, in the whole country. No matter how honest or wise Congressmen may be, it is a physical impossibility for them to have the knowledge of matters of local detail which is necessary if a fair judgment is to be formed. The fact is that if any such work is to be well done it must be done by the staff of experts connected with the executive department of the government, and the sooner the people of the country at large find this out, the better it will be for their National treasury.

Besides the impropriety, not to say rascality, of spending the public money on works of the character of that at Presque Isle, all such appropriations (and they aggregate a very great amount), operate to delay the completion of works of great public importance. General Craighill's hint, therefore, as to the necessity for restricting the works carried on under the new contract system to those of actual public necessity, is a very proper one. But how Congress is to be induced to give up its present privilege of playing engineer as well as appropriator of money, is a question we will not attempt to solve.

In another column we reprint the conclusions of the Report of the Deep Waterways Commission, as lately presented to the President. We postpone comment upon them until the full report is made public. As our readers doubtless remember, this commission, made up of Hon. James B. Angell, President of Michigan University; John E. Russell, of Leicester, Mass., and Lyman E. Cooley, C. E., of Chicago, Ill., was appointed by President Cleveland, under authority of a law passed March 2, 1895, to investigate and report upon the feasibility of constructing a ship canal, or canals, connecting the Atlantic Ocean and the Great Lakes. This commission was also to confer with such similar commissions as might be appointed on behalf of Great Britain or the Dominion of Canada, and they were to report upon the most convenient location and probable cost of such canals, and present any other facts and information relating to their con-

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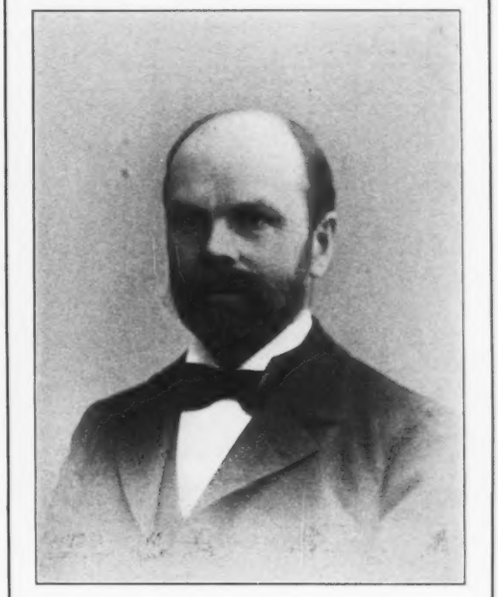
President of the American Society of Civil Engineers.



President of the American Society of Mechanical Engineers.

President of the American Institute of Mining Engineers.

President of the Society of Naval Architects and Marine Engineers.

THE PRESIDENTS OF FOUR AMERICAN ENGINEERING SOCIETIES.

TABLE I.—SHOWING DATE OF ORGANIZATION, NUMBER OF MEMBERS, GRADE OF MEMBERSHIP, DUES, FREQUENCY OF MEETINGS, AND METHODS OF PUBLISHING PROCEEDINGS OF 34 LOCAL ENGINEERING SOCIETIES AND CLUBS.

Name.	Organized.	No. of members. Start.	No. of members. Present.	Grades of membership.	Dues, active members.	Dues, non-res.	Receipts.	Secretary's salary.	Frequency of meetings.	Ave. attend. p.c. of total.	Manner of publishing papers and proceedings.
1. Association of Engineers of Virginia	1901	...	43	Mems.; Hon. M.; Assoc...	$5.00	$5.00	$139	None.	Monthly(a)....	30	Journal Association of Eng. Soc.
2. Boston Society of Civil Engineers	1848	12	429	M.; Hon. M.; Assoc.....	8.00	5.00	....	$200.00	Monthly(b)....	20	Journal Association of Eng. Soc.
3. Central Railway Club	...	...	...	One grade	2.00	2.00	....	.....	Monthly*.....	..	Monthly by the Club.
4. Chicago Electrical Association	1895	13	33	One grade	5.00	5.00	193	None.	Fortnightly...	66	Technical journals.
5. Civil Engineers' Club of Cleveland	1880	80	175	M.;As.M.; Hon.M.; Corres.	10.00	10.00	1,531	None.(c)	Monthly.....	37	Journal Association of Eng. Soc.
6. Civil Engineers' Society of St. Paul	1883	24	80	Mems.; Hon. Mems.	4.00	4.00	229	None.	Monthly(d)....	33	Journal Association of Eng. Soc.
7. Conn. Soc. of Civil Engrs. and Surv.	1884	25	86	One grade	3.00	3.00	320	$25.00	Annually.....	25	Annual report by the Association.
8. Denver Society of Civil Engineers	1882	21	(e)28	M.; As. M.; Hon. M.....	12.00	12.00	336	None.(f)	Monthly(b)....	28	Journal Association of Eng. Soc.
9. Engrs. and Archs. Assoc. of So. Cal.	1894	13	48	M.; Hon. M.; Assoc.....	5.00	5.00	221	None.	Monthly.....	40	By the Association.
10. Engrs. and Archs. Club of Louisville.	1890	40	80	M.; As. M.; Hon. M.....	18.00	5.00	1,008	None.	Monthly.....	25	In pamphlets from time to time.
11. Engineers' Association of South	1889	56	91	M.; Assoc.; Jun.; Corres.	4.00	2.50	...	$100.00	Monthly.....	17	Annual report by the Association.
12. Engineers' Club of Cincinnati	1888	58	132	M.; As. M.; Hon. M....	5.00	3.00	568	100.00	Monthly.....	20	Not published.
13. Engineers' Club of Columbus	1895	65	120	Mems.; Hon. Mems.	5.00	5.00	1,115	75.00	Fortnightly(g)	33	Not published.
14. Engineers' Club of St. Louis	1868	20	182	Mems.; Hon. Mems.	10.00	5.00	1,808	100.00	Fortnightly...	13	Journal Association of Eng. Soc.
15. Engineers' Society of Western N. Y.	1894	13	56	M.; As. M.; Hon. M.	10.00	7.50	610	None.	Monthly(b)....	20	At discretion of Executive Com.
16. Engineers' Club of Philadelphia	1877	23	407	M.; As. M.; Hon. M.	15.00	5.00	6,097	(h)	Fortnightly...	20	Quarterly by the Club.
17. Engineers' Society of Western Penn.	1880	184	400	Mems.; Hon. Mems.	7.00	5.00	2,253	None.(j)	Monthly.....	12	Monthly by the Society.
18. Illinois Society of Engrs. and Surv.	1886	40	120	Mems.; Hon. Mems.	4.00	4.00	694	$150.00	Annually.....	30	Annual reports by the Society.
19. Indiana Society of Engineers	1880	...	96	Mems.; Hon. Mems.	3.00	3.00	236	None.	Annually.....	25	Annual reports by the Society.
20. Indianapolis Engineers' Club	1893	75	65	Mems.; Hon. Mems.	6.00	3.00	175	None.	Fortnightly...	25	Not published.
21. Iowa Civil Engrs. and Surv. Society	1889	40	50	Mems.; Hon. Mems.	2.00	2.00	251	None(k)	Annually.....	30	Annual report by the Society.
22. Michigan Engineers' Society	1889	62	130	M.; Jun. M.; Hon. M.....	3.00	3.00	858	$125. (l)	Annually.....	33	Annual report by the Society.
23. Montana Society of Engineers	1887	48	65	....	8.00	6.00	400	None.	Monthly.....	12	Journal Association of Eng. Soc.
24. New England Railroad Club	...	...	...	One grade	2.00	2.00	...	.....	Monthly*.....	..	Monthly by the Club.
25. New York Railroad Club	...	...	500	One grade	2.00	2.00	...	.....	Monthly*.....	25	Monthly by the Club.
26. Northwest Railway Club	1888	20	298	One grade	2.00	2.00	2,064	None.	Monthly*.....	15	Monthly by the Club.
27. Ohio Society Civil Engineers	1879	...	130	M.; As. M.; Hon. M.	....	....	480	None.	Annually.....	25	Annual report by the Society.
28. Railway Signaling Club	1895	6	41	M.; As. M.; Hon. M.	3.00	3.00	...	None.	5 per annum..	30	Not published.
29. So. & Southwestern Railway Club	1890	12	198	One grade	3.00	3.00	1,102	$150.00	Quarterly*....	19	Monthly by the Club.
30. Technical Society of Pacific Coast	1884	200	160	M.; Hon.; Assoc.; Jun...	12.00	6.00	1,200	180.00	Monthly.....	19	Journal Association of Eng. Soc.
31. Western Foundrymen's Association	1893	20	120	M.; Hon.; Assoc Mem...	10.00	10.00	...	None.	Monthly.....	33.3	Monthly by the Association.
32. Western Railway Club	1885	...	900	One grade	2.00	2.00	...	.....	Monthly*.....	25	Monthly by the Club.
33. Western Society of Engineers	1869	...	441	M.; Assoc.; Jun. Hon. M.	7.50	7.50	...	.....	Monthly.....	25	Bi-monthly by the Society.
34. Wisconsin Polytechnic Society	1890	48	40	M.; Assoc.; Hon. Mem...	5.00	5.00	66	None.	Fortnightly...	20	Not published.

Notes.—*No meetings June, July and August. (a)Three formal yearly meetings, with informal monthly meetings, except from September to May. (b)Except July and August. (c)Hires some clerical work. (d)Except June, July, August and September. (e)In 1889-90 membership was 80. (f)Allowed amount of dues. (g)Monthly in April, May, June, and September, and not at all in July and August. (h)Has an office assistant (j)Assistant paid $600. (k)Actual expenses and dues paid. (l)Society votes what it sees fit.

struction and use. The full report has now been presented, and the President has submitted it to Congress with his approval and the recommendation that economical provision be made for such further prosecution of the commission's work as will more fully develop the information necessary for an exact and complete understanding of the important interests involved.

The British Commission, appointed soon after the American Commission, was made up of Oliver A. Howland, M. P., of Toronto; Thomas C. Keefer, M. Inst., C. E., M. Am. Soc. C. E., of Ottawa, and Thomas Monro, M. Inst. C. E., Department of Railways and Canals for Canada, of Coteau Landing. These two commissions acted in full accord, and the Canadian Commission made special surveys along the Richelieu River, from Lake St. Francis to Lake Champlain, for the use of the Americans.

THE DEVELOPMENT OF LOCAL ENGINEERING SOCIETIES.

In the organization and development of local engineering clubs and societies, American engineers manifest a degree of activity and interest which is equaled by the engineers of no other country. Besides the great national organizations of civil, mechanical, naval, electrical and mining engineers, whose acts and deliberations voice the engineering life of the country as a whole, there are to-day in the United States, upon a conservative estimate, some half a hundred local societies and clubs of engineers organized with written constitution and by-laws, holding regular meetings, publishing formal proceedings and papers, and carrying on business affairs which not infrequently attain a considerable magnitude. It thus appears that the local engineering society is an important element in the professional life of the American engineer; and it will be at least interesting, at this season, which custom has approved as the one proper for an inventory of past results and preparations for future efforts, to review briefly the progress which has been made in this local society work. Perhaps, too, we may be able to draw from this study some encouragement and some hints as to the direction in which the organization and management of these societies can be best improved.

At the outset it will be well to define just what the term "Local" Society covers, as in ordinary use its significance is rather elastic. It excludes, of course, all the societies which are professedly of national scope, and in our present discussion we have excluded also societies in connection with a single institution, such as those in engineering schools, those made up of employees of a single corporation, and purely social organizations like the Engineers' Club of New York and the Technical Club of Chicago.

After considerable correspondence we have gathered more or less complete information regarding the organization, growth and present standing of 34 different local engineering societies. Such of this information as could be tabulated has been arranged in the accompanying tables. This matter is to such a large degree self-explanatory that its discussion here may be confined simply to calling attention to a few particular features which bear upon points considered in succeeding paragraphs. First, it will be noticed that with a single exception every society records a growth in membership since its organization; second, either no salaries at all, or else merely nominal ones, are paid to the officers; third, and especially, regular meetings are held and provision is made for the publication of the papers and discussions presented at these meetings.

Turning now to the more general features of organization and management, the statistics collected show that these may be grouped for the present purpose under the following heads: (1) Legal status; (2) Qualifications for membership; (3) Finances; and (4) Government. All the societies named in the table have formal constitutions and by-laws, and a goodly proportion are legally incorporated, and have all the powers of corporate bodies to hold and transfer property, to sue and be sued, etc., which the law grants.

This corporate organization has been found to be especially desirable as the holdings of the societies increased and their financial operations extended beyond the circle of their own membership. Nearly all societies obtain a considerable proportion of their income from advertisements in their regular publications; and in soliciting and carrying out these advertising contracts the artificial personality and powers created by the corporation laws give the organization a prestige and standing which are valuable.

In the qualifications required for admittance to membership in the various societies, a great variation is found, as would naturally be expected; but in all cases these qualifications are lower than those required by the large national societies. In the various railway clubs the qualification is only that the person shall be interested in railway matters. The state engineering societies generally require actual surveying or engineering work for a year or more, or a diploma from some engineering school of good standing. From these qualifications the requirements gradually increase in severity until in the larger and older societies, like the Civil Engineers' Society of St. Paul, the Western Society of Engineers, and others of like standing, responsible charge of engineering work for from two to five years is required or a standing as a teacher or investigator which shall make the applicant presumably equal in professional standing. Architects, geologists, chemists and other practical scientific workers are generally received into membership upon the same basis as engineers. To present this matter in more definite and comparable form in the case of a few of the larger societies, Table II. has been compiled. In this table only the requirements for full active members are given, but most societies have lower grades of membership, with corresponding reductions in qualifications required in order to make the advantages of the society available to such of the younger and less experienced men as may not be qualified for full membership.

It will be seen that in most societies the doors are thrown pretty wide for the admission of members, and the result is that in every organization there are found besides engineers and other trained scientific workers a considerable number of manufacturers and dealers in engineering material and machinery. The proposition is often advanced that this very general admission of men engaged in promoting private interests may act to damage the professional standing of the society as an impartial scientific organization, and in theory the possibility is a potent one. Practically, however, it is doubtful if it cuts much of a figure. A pretty careful and extended observation has shown us very few instances in which the manufacturer as distinguished from the engineer has presumed upon his privilege as a member of a society to promote his personal interests in the papers and discussions of that society. To prevent any possibility of danger from this source it is provided in the constitution of some organizations that patented or commercial processes shall not be discussed except by a permissive vote of the society as a whole, and it is always open to the Board of Trustees or Editing Committee to exclude objectionable matter from the formal records of an organization by one means or another. On the other hand, the financial backing which the manufacturer or supply man gives the society in the way of dues and payments for advertisements is an important item in its income.

The money necessary for conducting the business of the societies is obtained from the entrance fees and dues of members, the sales of their publications, and from advertisements published in these publications. In order to give some idea of the amount of this income the column of "Receipts" has been introduced into Table I. As a general rule the expenditures run pretty close to

the receipts, but it is not usual to find a society in debt to more than a nominal amount. To this feature of "cutting the coat according to the cloth" the local society owes its stable and continued development in a very great measure. In most societies the expenditure of money is directly controlled by an Executive Committee, or some corresponding board elected by the voting members, and of this board the secretary is usually the active business agent. At regular intervals, generally annually, the accounts of the Secretary are audited and submitted in full to the members for approval. Ordinarily, none of the executive officers, not even the Secretary, receives pay for his services, but in the large societies this officer is allowed a nominal amount for expenses, or for the hire of an assistant, and in a few cases a fair salary is paid him.

In the general principle of organization the governmental machinery of all local societies is the same, but the details of organization are different in each society. To enter extensively into these differences of detail would entail an amount of labor and space which their importance hardly deserves, but a few words will explain the general principle. Local society government is republican and constitutional. As a typical example, the Engineers' Club of Philadelphia has been selected at random. The officers of this club consist of a President, two Vice-Presidents, and six directors who are the executive and managaing officers of the society and who appoint Committees on Finance, Membership, Publication, Library, Information and House. One Vice-President and three Directors are elected each year and they serve for two years. There are also elected by the members a Secretary and Treasurer, and these officers and the President serve for one year. Stated in the words of the constitution, the Board of Directors "has supervision and care of all property of the club, and shall manage and conduct its affairs in accordance with the charter and by-laws." If we substitute the proper changes in the number of officers and committees the form of government outlined above will answer very well as a description of almost any local society government. The Board of Directors is thus the formal governing body of the society, and to its discretion are left the finances, judgment of appropriate candidates for membership, discipline, and, in short, the whole executive government. This calls for care and wisdom in electing the executive officers. Ordinarily the good judgment of the nominating committee is depended upon to insure this care, but in a few societies constitutional requirements exist as to the character and qualifications of members of the executive board. It is especially as the society grows large in membership, making the mutual knowledge of the character and qualifications of each member which exists in a small club impossible, that such requirements became advisable. At the back of all government, however, is the constitution, and this can only be changed upon several months' notice, and then only by a very large majority vote of the members themselves.

This review of the statistics collected from the 34 local societies named brings us to the really important considerations in the role played by the local engineering society, viz., its objects and duties. In different society constitutions these objects and duties are stated variously, as, "the promotion of the arts and sciences connected with engineering"; "the professional improvement of its members and the advancement of engineering, in its several branches," and reiteration of the same idea and sentiment. In a broad way, the idea admits of two divisions, duties to its own members and duties to the public, and the consideration here will be under these heads.

The fundamental purpose which prompts the organization of an engineering society is the advancement of engineering knowledge among its members. All the machinery of organization and management are but the means to this end. The progressive engineer invariably seeks knowledge outside of his own experience by a study of the problems and methods of others, as given in professional treatises and in the technical journals, and welcomes the opportunity to associate himself with others in a formal organization for a mutual exchange of opinions and practice concerning the problems of his chosen life work.

The mutual exchange of knowledge in the engineering society is accomplished by the regular meetings of its members for the reading and discusison of papers, by the examination and study of engineering processes and structures through society excursions, and finally by the permanent recording of these meetings, papers, discussions, and studies in a printed publication. Without the meetings, papers and discussions, the final publication can have no being, and without the publication the other things fail largely in their chief purpose. In their provisions for publication all but a few societies are perhaps amply progressive, but the same cannot always be said of their production of matter for publication. This results partly from the disinclination of members to individual effort, and partly from the fact that when a member has developed a carefully prepared and valuable paper he prefers the wider circulation and greater prestige which its presentation before a larger and more powerful national organization, or in the columns of a widely read engineering journal, will give him.

The latter condition is a natural one and one from which the local society must always necessarily suffer. The lack of interest among the members, however, can in a great measure be overcome by proper effort and upon the executive officers of the society rests the responsibility of making this effort. Perhaps this should not be the condition, but it is. The average member pays the dues, elects the officers, and formulates the rules of proceeding, and then steps back and waits for the wheels to begin to revolve, apparently unconscious of the fact that he is one of the wheels, and that if he stands still the other wheels have to overcome his inertia and friction besides their own. To the executive officers falls first the duty of securing papers and developing discussions, for if these be able and vigorous, attendance at the meetings and material for publication will supply themselves. In one of the most successful local societies of which we know, the executive officers outline broadly a series of subjects to be considered during the year, and then make a direct appeal and secure a definite promise from one or more members to present papers on some branch of each subject at a definite date. This being done, a still further appeal is made to various members particularly interested or informed regarding that subject to discuss orally or by letter the problems and practices considered in the paper. In operation this scheme has resulted in a distinct improvement in the characters of both papers and discussions and in the attendance at the regular meetings. In another prominent society a similarly successful plan is followed to get the full benefit from excursions to manufacturing plants and engineering structures. Some member is requested to present in written form all the impressions, information and opinions he may have obtained from his examination of the process or structure, and at a regular meeting this is read and similar information is solicited from other members. To show concretely the result of this plan of work, it may be stated that the society proceedings of 1896 are richer by about 65 pages of comment and discussion as the result of one excursion to examine the processes of two great engineering industries. It may be that a better plan than the one outlined can be devised, but this one has worked well, and above all, it has shown what definitely directed personal appeal and encouragement can do.

We can take but little space for the mention of the library and reading room, the social entertainments and other important features of society work. These, however, are valuable adjuncts in securing that personal interest which is necessary to reach the best results in other lines.

Turning now to the public duties of the local engineering society, we encounter rather delicate ground. The individuals composing the club have the public duties of all citizens, and in so far as the society, as a whole, can influence its members to take a high and noble conception of their duties as members of an honorable profession, it manifestly has a public duty. But the opinion is frequently expressed that the society should go farther in its public functions than this, and that it should assume the role of an unpaid and disinterested expert, and prepare and present advice or criticism upon local engineering works, formulate laws and agitate for their enactment, and investigate and report upon disasters, accidents and failures of engineering structures.

The first thing to be said respecting this is that the tendency of the public to try to get engineering advice gratis has reached a point deserving of censure rather than encouragement. In the second place, in taking formal action upon questions which are often bitterly fought over, a society should always be cautious unless it can act with substantial unanimity.

The voluntary action of a professional society upon a matter of public importance ought to carry, and does carry, great weight with the public, and may often override all other authorities in its influence upon public opinion. If this power of the local engineering society is never abused, it may be a potent influence for good.

One way of exerting this influence is to secure the presentation and discussion of papers relating to proposed enterprises of local interest. We find an example of this in the work of the Engineers' Club of St. Louis, with reference to smoke abatement in that city. Although the subject was elaborately discussed in the club, both by individuals and by committees, no steps looking to organized action upon it were ever taken; instead, this work was left to a Smoke Abatement Association, which was organized for this purpose and had no other mission. In this association members of the Engineers' Club took a leading part, but they did so simply as citizens and not as members of the club. The end sought by the club was secured, but in such a way as to leave the freedom of individual opinion among the club members uncompromised in any way.

The past achievements of the local engineering societies, however, are fully as worthy of consideration as what can and should be done. It is gratifying therefore to be able to speak encouragingly of society work in this respect. What has been done in the material development of the local society needs little further mention than that accorded to it in the earlier paragraphs of this discussion, but a more important thing to note is what has been done by it to promote the knowledge and standing of the engineer, and to further the advancement of his profession. Evidently this is a thing upon which specific information cannot be given, but if every reader will inventory the advantage which he has gained from engineering society papers and discussions, from reading room and library facilities, from the personal friendship of the members of his society, from the influ-

TABLE II.—Showing Professional Qualifications and Other Requisites for Membership in 15 Representative Local Engineering Societies.

Society No. in Table I.	Qualifications for active members.[1]	No. proposers.	No. votes to reject.	Initiation fee.
1.	Proficiency as engineer or teacher.	3	5	$5.00
5.	Three years' actual practice	2	5	5.00
6.	Five years' actual practice	4	25%	5.00
8.	Two years' practice and proficiency.	2	5	10.00
9.	Proficiency, designer or constructor	3	7	10.00
10.	2 yrs' practical experience or diploma	3	5	10.00
11.	Active practice 5 yrs.; charge 1 year	5	5	....
12.	1 yr pract'cal experience or diploma	5	5	1.00
13.	Engagemt, scien. and mech. pursuits	2	5	5.00
14.	Actual engagem't, professional wrk	2	5	10.00
15.	Active practice for three years.....	4	5	10.00
16.	Responsible charge, wrk or teachers	2	5%	5.00
22.	Prac. surv. or engr., in good stndg.	1	5	3.00
29.	Actual professional practice, 5 yrs.,	3	7	5.00
32.	Active practice 5 yrs.; charge 2 yrs[2]	3	..	5.00

Note.—[1]Written statement of experience has to be submitted to and approved by Board of Directors before candidate's name reaches the members for vote. [2]Graduation from approved engineering school generally counts for two years' active practice. All elections are by letter ballot. Proposers have to assert personal knowledge of qualifications and character of candidates.

ence, prestige and solidarity of purpose which his membership has given him, and from the advanced standing of the whole profession due to society work, he can hardly deny that the accomplishment has been great. The local engineering society has been and is to-day a school of engineering whose influence is potent for the advancement of the engineer in every department of his profession.

In summing up this very brief discussion of the problems which the development of the local engineering society presents, it is recognized that no strikingly new facts have been evolved; but we believe none are necessary to the promotion of society work. A clear comprehension and faithful application of the principles which have proved the best guide in the past are all that is needed. Some of these have been briefly stated in the preceding paragraphs, and others will suggest themselves by a study of the information given in the accompanying tables. The time is especially appropriate for such study for the engineering societies are just entering upon a new year's work, and in many cases a new set of officers is at the helm.

LETTERS TO THE EDITOR.

Fiber Strains in the Montreal Bridge Designs.

Sir: In publishing the Montreal bridge competition plans you make no allusion to the fiber strains used. Inasmuch as we each had to make our own specifications it is difficult to compare the estimated weights without this data.

The use of the long anchor arms, as called for, greatly increases the cost and the deflection of the bridge, the only compensation being a finer looking cantilever on paper. What I mean by this is that after a bridge of such magnitude were built it would be impossible to get a point of sight that would give a pleasing perspective.

If the strains, weights and cost of erection of all these designs were estimated on the same basis, it would be found that the cost of Mr. Mertens' and my own design are almost identical and very much cheaper than any of the others.

I do not wish to be understood as objecting in any way to the award of the prizes, for we both disregarded the instructions as to the length of shore or anchor arms for the sake of economy and stability.

Yours respectfully,
T. Kennard Thomson.

277 Pearl St., New York, Jan. 9, 1897.

Tests of Water-Main Tapping Machines by the New York Department of Public Works.

Sir: It has come to our notice through the columns of several trade journals that a test of various water-main tapping machines at the Corporation Yard in New York city was made some time during the month of November. The items further relate that said tests were made under the supervision of the Commissioner of Public Works of the City of New York, invitations being sent to the leading tapping machine manufacturers in the United States.

Considering ourselves as a leading manufacturer of tapping machines we wish to state, in justice to ourselves and friends, that no invitation to enter this competitive test ever reached our office either directly or indirectly. The manufacturers of the winning machine in this contest are advertising the fact very liberally through the trade journals, and as this may reflect on the merits of other machines not invited to participate in the test, we candidly explain our situation in the matter. We are willing to back up the merits of our machine at any time in a competitive test. Yours very truly,

Decatur, Ill., Jan. 14, 1897. H. Mueller Mfg. Co.

(The moral which this letter points is: Read Engineering News. The exhibit to which our correspondent refers was announced on the first page of our issue of Oct. 15, was editorially commented upon in our issue of the following week, and notice of its postponement from Nov. 10 to Nov. 17 was given in our issue of Nov. 12. Our correspondent states that invitations were sent to the leading tapping machine manufacturers of the United States. It is probable that direct invitations were thus sent, but our impression is that the Department relied upon the engineering journals to make public the invitations.—Ed.)

"Black-Printing" Processes.

Sir: In the Engineering News of Nov. 27, 1886, you gave several formulas for black-process printing, which contain "hydrogen tartrate." I had the formula for "Gallic acid process" put up by a local druggist and it fails to work. I inquired of eight druggists (all there are in town) and none of them knew what Hydrogen tartrate was, or had ever heard of it. The one who put up the stuff for me used Tartaric Acid, which he said he thought was the same as Hydrogen tartrate. Was he right? If not, where can I get the Hydrogen tartrate? Is Gallic or tannic acid the ordinary Tannin? I suppose it would be much cheaper to have had my printing done away from home, but now that I have started, I would like to have these points cleared up if possible.

Respectfully,
O. E. Stanley, Asst. City Engineer.

Mason City, Iowa, Jan. 14, 1897.

(The receipt referred to by our correspondent was taken by us from a paper on "Heliography," presented by B. Howarth Thwaite, Assoc. M. Inst., C. E., to the Institution of Civil Engineers, and published in the Proceedings of that society, Vol. LXXXVI., pg. 312. The chemical nomenclature referred to is certainly deserving of criticism, but we think the interpretation of hydrogen tartrate as tartaric acid is correct. Another receipt for the "black process" was taken from an article on heliography written by A. Fisch for the "Photocopie," and published by us in our issue of Dec. 25, 1886. This seems to be practically the same as Mr. Thwaite's, and the sensitizing solution was made as follows, the materials being dissolved separately:

1. Gum arabic ..... 13 drams
   Water ..... 17 oz.
2. Tartaric acid ..... 13 drams
   Water ..... 6 oz.
3. Persulphite of iron.. ..... 8 drams
   Water ..... 6 oz., 6 drams

The third solution is poured into the second, well agitated, and then these two are added to the first, continuously stirring. When the mixture is complete, add slowly, still stirring, 3 fl. oz. 3 drams of liquid acid perchloride of iron, at 45° Beaume. Filter into a bottle and keep away from the light. By gallic or tannic acid is doubtless meant the ordinary tannin; though gallotannic acid, or that derived from nutgalls, is the commercial term of the acid referred to by Mr. Thwaite. We shall be pleased to hear from any of our readers who may have recent experience with black printing. —Ed.)

The Terminals of the Brooklyn Bridge Railway.

Sir: The very excellent editorial article on the above subject in your issue of Jan. 7 states fairly the development of a number of the engineering features of the Brooklyn Bridge terminals, but omits others of considerable importance, and, moreover, does not give me full credit for all I have done in the matter. As consulting engineer of the Committee on Terminal Facilities I made over twenty plans, many of them quite elaborate, including head-house, tail switching and rear curve systems, which practically exhausted the general features of the subject. When settlement was made with me after eighteen months' service, although my position had not been derived through the bridge engineers, I cheerfully acceded to the request of other engineers to keep quiet and permit the bridge engineers to work out my plans in their own way. This course has frequently put me in a false position until apparently authorized statements have been circulated to the effect that my original plans were rejected and that I had nothing to do with the present plans, or received compensation for doing nothing, etc. The first conclusion would also, in a less pointed way, be inferred from your article, which in connection with other statements, appears to demand an explanation from me.

The fact is that four out of five of the principal engineering features of the Brooklyn Bridge terminals, finally adopted and now nearly completed, were derived from me and that the other feature has caused the most important criticisms which have been made of the work. I first made a head-house plan on the now somewhat familiar double-starting track three-platform system, which exactly fitted the old station and brought down the distances to be walked and the height to be climbed by the passengers to a minimum. The foot passengers had, however, to climb another story, which was greatly criticised by the bridge engineers, although now all the passengers are obliged to climb to that height. The plan required a crossing in front of the station, and although, with six-car trains, increased capacity could be secured with the trains separated a safe distance, still the crossing was unfortunate and a subject of criticism. I accordingly worked out a double-starting-track tail-switching plan which was elaborated by the bridge engineers and finally adopted. In my original development of the plan the incoming trains were separated to two station tracks, there being three platforms to permit unloading and loading at the same time, and from these tracks the trains were to be alternately pulled out to the rear and pushed over the outgoing tracks abreast of the loading platforms and directly over the cables. To prevent the necessity of a switch in front of the station to the two station tracks I used "double single" or "gantletted" tracks over the bridge, which automatically separated the trains at the two station tracks. The tail switches were separate and the trains were to be delivered therefrom to a "double single" track over the cables, provision being made to have a cable in the center of each of the tracks so that half the trains were to be run by one cable and half by the other, both, of course, operated at the same speed. The bridge engineers changed this plan by employing two outgoing station tracks as well as two incoming, and their first plan thereof, known as the "Barnes" plan doubled my three platforms, except the intermediate, thus requiring five platforms. I called Maj. Barnes' attention to the fact that but two island platforms were necessary, one between the two incoming and one between the two outgoing tracks, and this feature was immediately adopted and finally the plans at present nearly carried out were worked up in detail by the bridge engineers.

It will thus be seen, as was easily shown by evidence when the question of my compensation came up before a committee of the Board, that out of five features adopted four were derived from me, viz.: First, double station platforms and tail switches, by which alternate trains are separated so that a train in the station is not threatened by the train immediately following, but only by the second following train; second, the use of gantletted tracks to separate the trains to the two station tracks without the use of switches; third, the use of double cables, one in the center of each of the gantletted tracks; fourth, the use of two island platforms instead of five platforms, as in the Barnes plan. The bridge engineers were entitled to the other feature, viz.: the employment of double outgoing station tracks separating the loading and unloading, instead of requiring passengers entering from one end and one side door of the car to displace passengers in the car from the other side of the train through the other side door and other end, as I proposed, so that when the train was unloaded it was loaded. My arrangement was practicable and had the decided advantage that both series of trains could take the cable directly opposite the station platforms. The modification of course had its merits, but its application involved a serious difficulty. Col. Paine's grip system had after a long series of experiments been so worked out as to operate satisfactorily, and all agreed that it should not be disturbed. I did not believe that it could be operated on curves if above the rails, and therefore provided to bring the tangent on both outgoing tracks back to the platforms so that the cables could be gripped there without following either train out with a switching engine. With double outgoing tracks the train on at least one of the tracks would have to be pushed away from the platform by a locomotive, and the time required for this engine to get back again so that the next train could come in that stall, so to speak, would reduce the capacity. For some reason connected with the ground space neither of the outgoing platforms were put over the cable in the design of the bridge engineers, and trains on both had to be pushed out. The first plan of the bridge engineers was to do the rear switching by cable so as to avoid the running of an engine out behind each train, but I called attention to the impracticability of doing this unless the grips were depressed below the level of the rails, and in working out the plans finally the bridge engineers were forced, without my knowledge at the time, to elevate the whole station another story so that the trains on the starting platforms need only be pushed a little way and then would run down grade to the lifting sheaves outside the station, grip the cable at the change of grade on the main approach and proceed. This explains why all passengers for Brooklyn, after climbing to the original height of the platform, must, even if lame, halt or fatigued, climb still another story to take the cars, and excuses the present agitation on the subject of elevators. This plan was approved by the Spencer-Buckholz-Plympton Board of Experts. I had as the result of further study of the subject submitted to this Board a method of obviating the crossing in the tail switches, an improvement on an alternate method submitted to the former Board, which involved an approach curve to the southward over Frankfort St., behind the World Building, but special devices were required and the Board did not consider the crossing as important as I did and the plan was not adopted, although the old station, the old level and six-car trains if desired would have been secured without grade crossings. When the present plan was adopted I begged of the engineer of the Board of Trustees to reconsider it, but, if the plan was to be adhered to, urged that one of the outgoing tracks be put over the cable and that a return track be provided for the other station track so that the engine could go through the station with the train and come around to the rear on the extra track, as it had not then been explained publicly that the whole station was to be raised to overcome the difficulty.

In due time the construction proceeded and coincidently therewith the enormous development in electric traction took place, of which I made a special study, and at an early date, in conversation with the President and Engineer at different times predicted that the cars would be switched by electricity. As the work neared completion I urged the

Chief Engineer to have the matter investigated by some one who not only understood the bridge but the electrical features, urging that if the matter were put on a commercial basis the electrical companies would put in the best thing for some other place, but not the best for the bridge, giving reasons. He, however, adopted the commercial plan, and the result is exactly what was predicted. The motors recently put in operation are certainly well designed and the best that could have been used elsewhere than under the conditions on the bridge. They have ample power to do the switching, and from the fact that they go with and form part of each train, the complication due to getting rid of the locomotive above referred to is eliminated, consequently the space between trains can be reduced and objections on that point are overcome, as you intimate in your article.

The fact is, however, that these motors are not fully adapted for the location. In the first place, the roadbed is ill-calculated to withstand the weights due to the continual passage of locomotives, even though arranged in the trucks of a passenger car. The double rails close together add stiffness, and it is possible the system will only affect the expense account without injuring the bridge structure. There would have been no risk had the engineers taken my advice, though volunteered, and insisted upon motors on each car. Such motors could have been applied of sufficient power with substantially the same aggregate weight, and would have, therefore, distributed the load better and permitted the use of the cable on all of the cars, whereas now a grip cannot be applied to the motor car on account of the size of the motors. The principal point, however, is that motors on each car would have greatly increased the adhesion. With the present motor cars, if the cable fails in sleety weather, as it has, the motors will also fail from defective adhesion and we shall find the bridge inoperative in the future as it has in the past at the very time it is most needed. Such a failure has already taken place once. The present motor cars have about one-third of the total weight of train on the drivers, which is ample to surmount even the 3¼% grades in good weather. In street railway traction 100% load on the drivers has been found necessary in many locations and is generally employed. This could have been obtained on the bridge railroad by putting a motor on each axle, but it is probable that a motor in each truck would have been sufficient. This would have increased the adhesion about 50%, with balanced trucks, and sensibly more with eccentrically loaded trucks ("maximum traction"), now used to a considerable extent.

Although this communication is lengthy it may be stated briefly that my improved plans, which obviated all grade crossings, retained the double starting tracks, gantletted rails and double cable system and involved a curve in New York, as explained. In Brooklyn, however, tail switches, one nested within the other, were to be employed, avoiding grade crossings for circulating trains and giving superior facilities for connection to the storage yards. This plan can yet be applied at trifling cost in Brooklyn and in New York by simply crossing Center St. and trespassing a little on the old Hall of Records.

Chas. E. Emery.

Bennett Building, New York city, Jan. 9, 1897.

STEEL FOR BOILERS AND FIRE BOXES.*

By T. L. Condron.

The material for this paper has been collected from the motive power departments of several railways, a few of the locomotive works and steel manufacturers. About 50 replies have been received by the writer to a circular letter. So far as possible the experiences given in these letters are brought together in condensed form under appropriate headings in this paper for ready reference by all interested.

Fire-Box Steel.—Upon the diagram there have been plotted those requirements in 32 specifications which can be expressed in figures. This diagram shows at a glance how many of the roads have adopted the specifications recommended by the Master Mechanics' Association in 1894. Wherever a specification differs from the Master Mechanics' Association specification, the difference may be noticed by an off-set from the continuous bands, and the exact limits are shown on these off-sets by figures. Some specifications permit an increase in tensile strength and reduction in elongations for thin plates, and this is indicated where proper by a small jog at the extreme left of the space given to that road.

The limits allowed by each specification are indicated by dark spaces. The dotted lines indicate what is desired in each case.

Chemical Requirements.—It seems hardly necessary to specify the limits for all the different elements entering into steel and at the same time make rigid physical requirements. The writer is strongly in favor of limiting the amount of phosphorus and sulphur in the steel and likewise the amount of manganese, but believes that it is unnecessary for the buyer to go further than this. Excesses of these three elements tend to make the steel unreliable. Steel high in phosphorus may give a satisfactory test, but surface inspection will discover numerous pits and scales on the plates, and while some plates may look smooth the inequalities of the steel will develop in service. The same is true of sulphur and manganese in differing degrees. Several correspondents have spoken of plates failing in service, which plates, when analyzed, were found to be high in either phosphorus or sulphur or both.

The limits of phosphorus and sulphur should not exceed .03% in each case. The limit of 0.35% to 0.50% for manganese adopted by the Illinois Steel Co. is good.

Tensile Strength.—It is at once seen that several roads have not adopted the high tensile strength specified by the Master Mechanics Association, while the specifications adopted by the Association of American Steel Manufacturers are in marked contrast to the latter. Several roads write that they have decided to use only certain makes of steel for fire-boxes and prefer to specify simply the best product of these makers and not attempt to get the benefit of buying in the open market upon rigid specifications of their own. In every case the makers spoken of in these letters are members of the Association of American Steel Manufacturers, and naturally it may be inferred that these makers adhere to the specifications of their association.

The Carnegie Steel Company, Ltd., writes that it has been their experience that a steel of less than 62,000 lbs. tensile strength has been the most satisfactory to their customers, and adds that this statement is based upon the records of their Claims Department. The Illinois Steel Co. recommend an upper limit of 60,000 lbs. for fire-box plates.

The specifications of the Association of American Steel Manufacturers were adopted, after a very full discussion of the subject by all of the plate manufacturers of the country, and while a few preferred to have a range of 50,000 to 58,000 lbs., the opinion of the majority favored the 52,000 to 62,000 lbs. range for fire-box steel. This shows that experience has led the steel makers to recommend very soft steel for this use.

In the same connection this statement is received from the Union Pacific road:

> Until three years ago we allowed a limit of 65,000 lbs. in the tensile strength. For 2½ years our experience with steel of from 50,000 to 56,000 lbs. tensile strength leads us to believe that it is better material than that of a higher tensile strength, as it is less liable to crack.

From the New York, Chicago & St. Louis R. R. comes the report that they specified a tensile strength, desired, of 56,000 lbs. for 12 new boilers and fire-boxes built in 1895. And an elongation of 26% and reduction of area of 60%, which they feel insures a good ductile steel.

The statement of one corespondent, that "what is most necessary to guard against in plates and stay-bolts is cheap material which is on the market, and the following of specifications of parties not familiar with actual manufacture," has a great deal of wisdom in it.

Although the Illinois Steel Co. is a member of the Association of American Steel Manufacturers, their specifications for fire-box steel are noteworthy in that they place the ultimate strength at from 50,000 to 60,000 lbs., and differ from the association in chemical requirements as indicated.

Elastic Limit.—It is noticeable that the specifications all omit any reference to this property of the steel, and experience goes to show that it is quite as well to do so, as the "elastic limit" is such an indefinite point when determined in the ordinary way that it is a poor operator indeed that fails to secure on a testing machine the elastic limit above one-half of the ultimate strength.

Figs. 3 and 4 are interesting as showing the wide variation in the elastic limits. Fig. 3 represents 100 tests made at the Homestead mill of the Carnegie Steel Co., Ltd., and Fig. 4 about 400 tests made at the South Chicago mill of the Illinois Steel Co. The first lot of tests were made on a machine having the counterpoise controlled by a hand wheel. The second lot on a machine on which the counterpoise is operated automatically. In the first case there is a decided personal equation of the operator keeping his scale beam balanced, which affects the determination of the "elastic limit," and usually this is recorded two to five thousand lbs. too much. In the second case the only personal equation is in selecting the point to record as the elastic limit. As the stress approaches the elastic limit of the specimen the scale beam generally drops and rises again several times instead of only once. The Figs. 3 and 4 seem to show how little value can be attached to the "elastic limit" as determined in commercial testing.

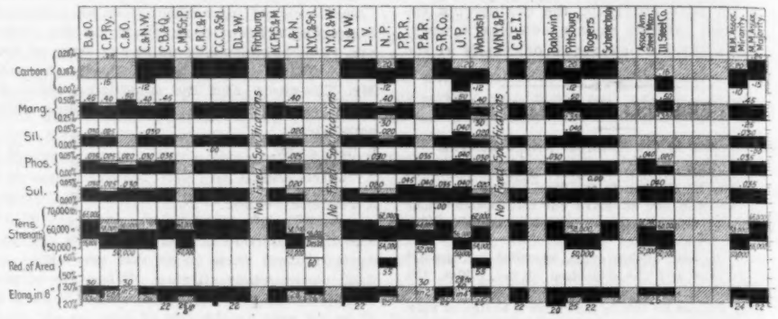


Fig. 1.—Diagram for Firebox Steel.

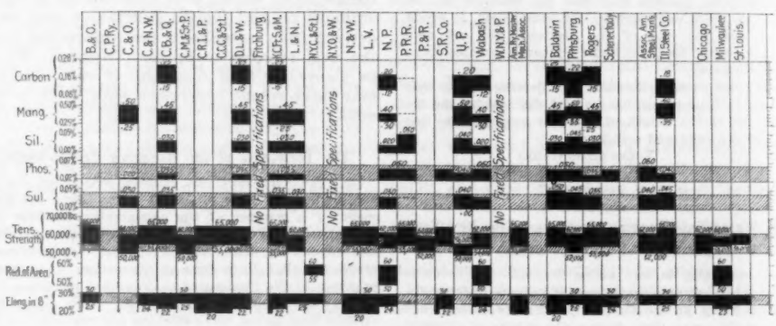


Fig. 2.—Diagram for Boiler Plate Steel.

FIGS. 1. AND 2.—DIAGRAMS SHOWING COMPARISON OF THE STANDARD SPECIFICATIONS FOR FIREBOX AND BOILER PLATE STEEL IN USE BY VARIOUS RAILWAY COMPANIES WITH THE STANDARD SPECIFICATIONS OF THE MASTER MECHANICS' ASSOCIATION AND THE STEEL MANUFACTURERS' ASSOCIATION.

Reduction of Area.—The writer is inclined to believe that there is no great need for this being noted in addition to the elongation. It is true that it adds but little trouble in recording the test, as it does not necessitate an extra setting of the slide rule.

Elongation.—While the Association of American Steel Manufacturers specify a minimum elongation of 26% in 8 ins. the Master Mechanics' Association specifications and those of nine railroads drop this to 22% and one company even lowers it to 20%. This surely is not wise. What is needed for fire-boxes is a ductile steel, and an elongation of 24% is certainly none too low. The $\frac{1{,}450{,}000}{T.\ S.}$ of the Pennsylvania R. R. is equivalent to 26.4% for 55,000 lbs. tensile strength and 22.3% for 65,000 lbs. tensile strength. There is good logic in this sliding scale, but it is cumbersome.

Bending Tests.—Too much stress cannot be laid upon the importance of making hot and cold and quench bend-

*From a paper read before the Western Society of Engineers and printed in the "Journal" of the Society.

ing tests upon steel for boilers and fire-boxes. These tests are easily made, and unquestionably they are as important as the more elaborate tensile tests.

Transverse Tests.—Where it is desired to get the very best plates possible it should be required that test specimens be cut both lengthwise and crosswise of the plate for bending. Often it is found that plates which will show a good test in the direction of rolling will fail completely in a transverse test. Indeed, it would seem best to have all tests cut transverse to the direction of rolling, as in case a defective ingot was used the transverse tests would show the fact more certainly, and the steel is always weakest in this direction.

(An exception may be taken to this statement of the author. It quite frequently occurs that test pieces cut transversely to the direction of rolling show higher ten-

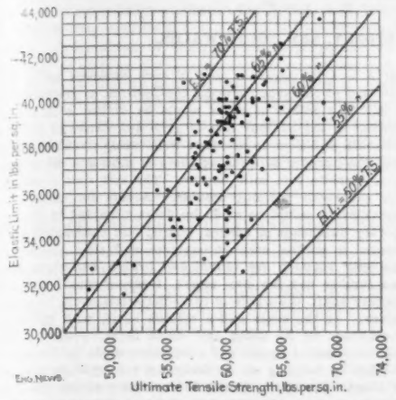


Fig. 3.—Elastic Limit Determinations with Counterpoise of Testing Machine Moved by Hand. Made at the Homestead Mill of the Carnegie Steel Co.

sile strength than those cut with the direction of rolling. If an ingot is solid and homogeneous throughout, heated uniformly and rolled to a uniform thickness, it should make no difference from what portion of the plate the test piece is cut. If, however, the ingot contains blow-holes or is "piped," the flaws caused by the pipe or blow-holes may cause a test piece which contains these flaws to be weaker than an adjoining piece which is solid. The direction of rolling, whether with or across the direction of the length of the ingot, may have some influence upon location of the flaws in the rolled plate and upon the chances of a test piece containing these flaws. Differences in temperature of the ends of the ingot may also have an important influence upon the strength of test pieces taken from the two ends.—Ed. Eng. News.)

There is always a marked difference in the tests taken from the two extreme ends of a long plate. This difference

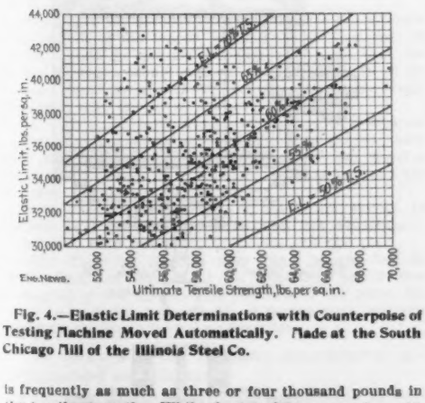


Fig. 4.—Elastic Limit Determinations with Counterpoise of Testing Machine Moved Automatically. Made at the South Chicago Mill of the Illinois Steel Co.

is frequently as much as three or four thousand pounds in the tensile strength. While the test from one end would pass the plate, the test from the other end would not.

The homogeneity test given in the Master Mechanics' specifications is also a very excellent one and should always be made for both boiler shell and fire-box plates.

Boiler Shell Steel.—Fig. 2 shows a comparison of specifications for boiler shell steel in a similar manner to the comparison of fire-box steel in Fig. 1. In this figure the light bands across the diagram represent the requirements of the specifications adopted by the Association of American Steel Manufacturers.

Thin Plates.—It seems a mistake to admit thin plates of higher tensile strength and lower elongation than is required for thicker plates. Of course this is necessary if rigid chemical requirements are made, but it is more reasonable to require that thin plates shall be more, rather than less, ductile than thick ones, for the tendency to crack from a rivet hole is greater in a thin plate than in a thick one.

Iron vs. Steel for Fire-boxes and Boilers.—The general consensus of opinion favors steel rather than iron plates, even if it were possible to get iron of uniformly high grade. The Chicago, Burlington & Quincy R. R. tried "Sligo iron" fire-boxes in the '70's with poor results, and this seems to be the experience of a large number of roads. The New York, Ontario & Western Ry. has in service now a locomotive built by the Baldwin Locomotive Works in 1872 with 16×24-in. cylinders and 63-in. driving wheels which still has its original fire-box of "Bay State steel" and this box is apparently in as good shape now as ever. This engine is still running in the regular passenger train service.

Boiler Flues.—A prominent boiler maker gives the following statements regarding charcoal iron:

> There is no question as to the relative wearing qualities of iron and steel with regard to corrosion, the advantage being in favor of the iron. Charcoal iron flues are better than steel flues for certain waters. On the other hand, it is very hard to secure a pure charcoal iron flue at the present time, and a first-class open-hearth steel flue is even better than the very best charcoal iron in many instances.

He further states that he has on file a letter from one of the highest priced tube manufacturers stating that the so-called "charcoal iron tubes" which they make are not charcoal iron at all, and if such a thing is wanted their customer must wait while they run through a special order at an increase of 40% in the price. This leads our correspondent to believe that a good quality of steel is to be preferred to any of the so-called charcoal iron tubes on the market, since the latter are not made in sufficient quantities to insure good quality of material.

Stay-Bolts and Rivets.—Iron is unquestionably to be preferred for stay-bolts and rivets, but this paper is intended to treat of plates only.

EXPERT REPORT ON THE PROPOSED JERSEY CITY WATER CONTRACT.

Another interesting contribution to the water-works controversy in which Jersey City has been engaged for so many years has just been made in the form of a report by Mr. George W. Rafter, M. Am. Soc. C. E. This report was made to the Jersey City Board of Trade, which body engaged Mr. Rafter to examine the specifications for a new water supply under which bids were received on Aug. 24, 1896; to report on the several bids submitted under those specifications, especially the bid of the East Jersey Water Co., accepted by the Board of Street and Water Commissioners on Dec. 4*; and incidentally to examine the Passaic River, at the Belleville pumping station of the Jersey water-works, with a view of expressing an opinion as to filtering the present supply.

Mr. Rafter first takes up the specifications, which, in brief, were for (1) a gravity water supply from a new source, to be furnished at stated prices per 1,000,000 galls. in quantities from 20,000,000 to 50,000,000 galls. per day, the city to have the option of buying the plant and choosing between works with capacities of 35,000,000 and 50,000,000 galls. per day, respectively; (2) for a filtered supply from the Passaic River.

The specifications gave as a standard for testing the capacity of proposed drainage areas certain tables in the "Report on Water Supply," published by the New Jersey State Geological Survey. Mr. Rafter, while praising the report as a whole, thinks the tables cited give somewhat too high a yield for the particular drainage areas in question. The East Jersey Water Co. offered 66.4 sq. miles of the upper drainage area of the Rockaway River, as sufficient for a daily supply of 50,000,0000 galls.

The clauses of the specifications relating to the number of conduits Mr. Rafter pronounces

> not only incomplete, but so indefinite as to render it absolutely impossible to obtain bids which are in any degree comparable.

The report states that the specifications call for either two or three conduits, where metal is used for the same, and makes numerous citations from the specifications in support of this claim.

We pointed out in our issue of Dec. 10, that the whole intent of the specifications seemed to indicate that more than one conduit was required, and that therefore the accepted bid was informal. We did not discuss the relative desirability of one as against two supply mains, but Mr. Rafter strongly expresses himself as in favor of two, as a matter of safety.

Regarding the general character of the conduit, Mr. Rafter says:

> Those clauses of the conduit specification relating to design, material, workmanship and strength are not, in my opinion, in line with current engineering practice.

It is further pointed out that whereas the specifications demand that bids must state the character of the proposed conduits, and fully describe them, the accepted bid is silent on this point. Very interesting in this connection are some statements which Mr. Rafter applies to the specifications and the award, as follows:

> The inspection clause provides that the contractor shall furnish the city with all plans, details and working drawings, the city reserving the right, through its engineer, to supervise the work, inspect the material and labor, and reject if not in acordance with the specifications and the plans accompanying the accepted bid.
>
> Inasmuch as the specifications are absolutely silent as to the quality of material and work to be used in the construction of the said works, I cannot but think that this clause is superfluous, although a proper inspection clause would be of very great importance in properly drawn specifications.

The dimensions of the conduits offered in the various bids of the East Jersey Water Co., Mr. Rafter deems sufficient to meet the contract requirements for capacity, but the conduits offered by the Rockaway & Hudson Water Co. are considered less liberal, while one of them is thought to be so deficient in capacity as to rule out that bid of that company.

Another important point brought out in the report is that while the specifications demand that the location, character and capacity of each proposed storage reservoir shall be clearly indicated in the bid, neither of the bids are sufficient in this particular. Further, the bid of the East Jersey Water Co. contains the following:

> As the time for making these bids has been too short to make borings and examine the foundations of the proposed reservoir dams we suggest that the contract should provide that in case explorations and borings should develop that the subsoil is unfit for the construction of safe and practical dams, other reservoir sites of equal value and efficiency in furnishing water may be substituted for those now offered.

This quotation substantiates the arguments advanced by this journal last spring to the effect that the time allowed for submitting bids was altogether inadequate for the preparation of proper plans and estimates.*

Mr. Rafter points out how the bids might be, and doubtless were, increased through basing estimates on both indefinite specifications and uncertainties regarding the natural conditions to be encountered in construction. At the close, he sums up his conclusions as follows:

> (1) The specifications prepared by the Jersey City Board of Street and Water Commissioners are so contradictory, indefinite and incomplete as to render rational bidding impossible.
>
> (2) The bids submitted by the East Jersey and the Rockaway and Hudson Water companies, under the specifications, are incomplete and informal, and should be rejected.
>
> (3) The watersheds proposed by both companies, under their bids, Plan B, are satisfactory as regards purity of water; but the area proposed by the East Jersey Water Company appears somewhat too small to absolutely insure a full supply in the year of minimum run-off.
>
> (4) The cost to Jersey City of water, either for permanent supply when the works are purchased,or for supply under the rental clause,is apparently somewhat higher than can probably be obtained by more businesslike procedure as to the preparations of general plans by the city, and the submission to the proposing companies of a rational specification.
>
> (5) Taking experience abroad as the basis, there seems to be no reason why the water of the Passaic River could not be efficiently purified by filtration.

*For detailed bids, see Eng. News, Aug. 27, 1896, and for editorial discussion of bids and awards, see Eng. News, Dec. 10, 1896.

PROPOSED SUBAQUEOUS VIADUCT AT SYDNEY, NEW SOUTH WALES.

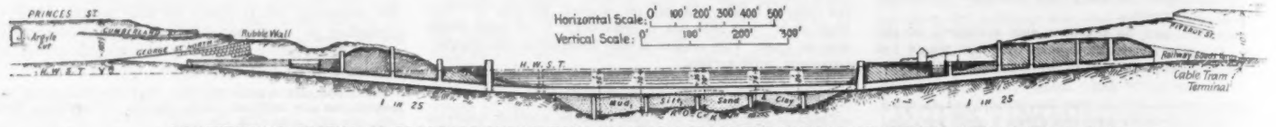
The city of Sydney, New South Wales, Australia, and the authorities in charge of the Government railways and street railways, have long been desirous of having a direct means of communication between the city and its northern suburb, which are on opposite sides of the harbor. The ferry traffic has increased from 80,000 per day, three years ago, to 100,000, owing to the development of the suburban residential district, and the traffic is still growing. Various bridge and tunnel plans have been proposed, but the authorities declare that a low level bridge, with draw spans, is not permissible, and that any bridge across the harbor

*See Eng. News, April 30, May 7 and 14, 1896, the latter issues containing letters from Mr. C. C. Vermuele, Consulting Engineer to the Jersey City Street and Water Commissioners, with editorial comments.

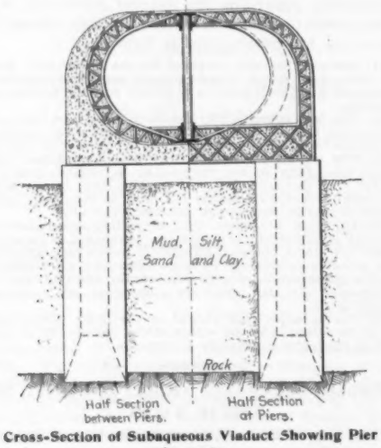
must be of one clear span, and have a headway of 160 ft. The width of the channel is 1,490 ft., with 52 to 60 ft. of water at high tide, and a tidal range of 4 to 5 ft. The bed rock is shown by borings to be 75 to 96 ft. below high water, and this is covered by a bed of silt, mud, clay and sand from 22 to 40 ft. thick. A tunnel through the silt would be a difficult undertaking, as the shield would have in places only about 2 ft. of cover, besides which the grade line for the electric railway would be 78 ft. below high water, requiring steep grades or long development for the approaches.

The latest plan proposed is to build a submerged viaduct on top of the silt bed, supported by piers carried down to the rock. This plan has been worked out by Mr. A. M. Howarth, of the Railway Construction Department, and is shown in the accompanying cuts. The depth of water over the tubes would be 36 ft., or 6 ft. more than that at the entrance to the main channel of the harbor. The rail level is 17 ft. above that of a tunnel, or 51 ft. below high water, and with approach grades of 4%, the viaduct would be 850 ft. shorter than the tunnel when measured between the same terminal levels. The cost of a double tube viaduct for steam and electric railways is estimated at $925,000, while a third tube for vehicles and pedestrians would cost $450,000 more, making $1,375,000 in all. The high level bridge suggested by the Royal Commission would cost about $3,600,000, while its cost for maintenance would be greater and its traffic capacity would be no greater. The following as an abstract of a paper read by Mr. Howarth before the Engineering Association of New South Wales, describing his proposed plan. The plan is by no means entirely novel, and resembles somewhat closely that of Mr. Strom, which was described and illustrated in our issue of February 28, 1891.

A cantilever bridge, with a channel span of 1,500 ft., and a roadway of 160 ft., as required by the authorities, would have a total length of 4,935 ft., including approaches, and would cost $3,725,000; while a double tunnel through bed rock, 1,680 ft. long, would cost $1,050,000, with spiral or circular approaches, or $950,000 with vertical shaft approaches fitted with elevators. A similar tunnel driven through the mud and silt forming the bottom of the harbor would cost still less, and the length of tunnel approach would be about 20% shorter than the all-rock tunnel of the second example. As this saving is entirely due to the raising of the rail level at the center of the harbor, it is reasonable to believe that if we were to lift the tubes (their upper surfaces offering no obstruction to navigation) and thereby placed the rail level at a minimum depth below water, we should then obtain the ideal short passage subway, and be more certain of that popular patronage which is essential to commercial success. A clear depth of 36 ft. from high water spring tide mark to the tops of the tubes would be amply sufficient for all requirements of navigation. The rail level would then be 50½ ft. below water level, and the subway would be 3,498 ft. long. The bottoms of tubes would be 53 ft. below water level, and, as nearly half of their length would be above and clear of the soft surfaces of the mud and silt, their stability and alinement would have to be preserved by rigid connections with the bed rock of the harbor. This vertical transposition of the tubes and the employment of pier supports, transforms the original mud and silt surrounded subway tubes into a subaqueous bridge or viaduct.



LONGITUDINAL SECTION OF PROPOSED SUBAQUEOUS VIADUCT ACROSS THE HARBOR OF SYDNEY, NEW SOUTH WALES.



Cross-Section of Subaqueous Viaduct Showing Pier Supports.

The circular tube, when treated as a beam, does not show the economy of material possessed by the conventional type of flanged girder, and in recognition of this fact, I propose a form of cross section that will enable us to calculate all working stresses as would be done for an ordinary flanged girder with a rigid web. Assuming that the bridge is intended to carry two lines of way, the cross section would be as shown. The middle partition is the web of a girder, whose flanges are clearly shown to be embedded in the protective and cement filled chamber between the inner lining and outer casing. The roadway passages would be formed by attachment of semicircular wings to the top and bottom flanges of central girder. These wings are designed to transmit all working loads to the central girder. The outer casing or envelope is built 2 ft. away from the wings all around, and would be retained in position by light bracing until the concrete filling was completed and perfectly set. It will be seen, therefore, that the inner wing plates could be replaced when required, and though the outer shell would, at some indefinite time, corrode and fall away from the bridge, the presence of the age-hardened concrete wall 2 ft. thick, would preserve the wings and girders from damage by salt water. The length of each span is about 210 ft. This length conforms to good practice in economic continuous girder building, and would be convenient to handle when being placed in position. Each tubular span would be completely finished on shore, with the ends securely closed by temporary bulkheads, and then be floated and towed out to the position indicated for sinking.

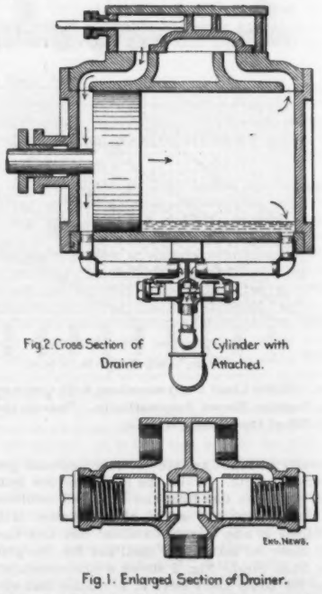
The piers are of the ordinary central well type, and judging by cross section of harbor, not more than 314 lin. ft. of sunk cylinder would be requisite for the founding of the five piers. Assuming that 400 ft. of cylinder be required, and the finished price was $125 per ft., I think it will be generally admitted that $50,000 is not an extravagant price to pay for five rock borne supports for the bridge. The ends of each span are splayed out on wings and bottom, and are provided with flanges on the lining and casing. The flanges would be drilled to standard templates for the reception of joint bolts. The temporary bulkheads in tubes would be fitted with air-lock doors, and be set back 3 ft. from end, so that when two spans were brought together, a convenient working chamber would be provided for the divers when bolting the flanges for a water-tight joint. The gross buoyancy of bridge per lineal foot is 12 tons, the actual weight is 11.1 tons per ft. This means that when the bridge was empty there would be an upward bending moment equivalent to 2,016 lbs. per lin. ft., and if we impose a total rolling load of 33,600 lbs. per ft. for the double line, we should change the upward load of 2,016 lbs. into a downward load of 1,344 lbs. per lin. ft., and by so doing produce a bridge which would be safest when crowded with traffic from end to end. It is evident that such favorable working conditions permit us to secure a very large factor of safety with a minimum expenditure of material. This factor is sufficient to provide for the remote contingency of accidental flooding of tubes prior to the final completion of the bridge. The influx of water could not possibly occur, excepting by injury to bulkheads or negligent use of water-tight doors when the various tubes were being joined. The flooded bridge would receive an extra load of 710 tons per span, or 3.38 per lin. ft. As no other loading would be possible with water in the tubes, we need only provide for this additional load at each pair of pier cylinders. Each pier has a bearing area of 102 sq. ft., with an ordinary working load of five tons per foot. The additional load of seven tons due to flooded tubes, equals 12 tons, and this would be perfectly safe.

It would be practically impossible to capsize or displace the bridge by side pressure, even though the silts and other deposits might be softened and scoured by tidal currents or by future dredging operations. In plan, this bridge presents itself as a horizontal, continuous six-span tubular girder, fixed upon five intermediate piers and two rigid abutments. The cylinders are securely fixed to superstructure, and being only three to five diameters long, they can be treated as vertical cantilevers, and relied upon to transmit to the bed rock all horizontal forces of the continuous girder at each pier.

At the Sydney end connection is proposed to be made by a tunnel 200 ft. long, and driven through rock and soil. The approach tunnel having been driven to a vertical shaft and a temporary shaft having also been sunk at the Sydney end of the bridge tubes, a temporary embankment of clay in bags would then be formed between the two shafts. The clay bank would range from 5 to 7 ft. deep, with an average width of 36 ft. Ordinary iron tubes, about 2½ ft. diameter, with solid pointed ends, would then be driven at 3 to 4 ft. intervals, and in such numbers as to fill a portion of the area covering the position of proposed tunnel. The points of tubes would be driven within a few inches of the contour line of arch and flanks of proposed tunnels, and then be provided with inside circulating pipes for the purpose of freezing the soft mud and water bearing deposits into solid matter. The soft core could then be excavated without trouble. Access for miners and bricklayers would be made by doors provided in the temporary bulkheads of vertical shafts. On completion of the tunnel a sealing arch of concrete and steel would then be built between the tunnel and bridge, and there being no further use for clay banks, freezing pipes, and temporary shaft, the whole of these materials could be cleared away. At the other end a caisson shaft, with temporary bulkheads on its north and south faces, would be sunk to the required depth, and connection made to tunnel and bridge by jointing up as described for separate spans of viaduct. Electricity would be used for traction and lighting purposes, and the whole of the approaches and viaduct would be lined with white enamelled encaustic brick and tile. Two ventilating shafts, each 200 sq. ft. area, and eight others of not less than 50 sq. ft. area each, would be provided. The estimated complete cost of construction and equipment, exclusive of cars and electric power plant, would be $925,000. The whole of the quantities and prices are based upon colonial labor and materials, and the estimated time required for construction is two years.

AN AUTOMATIC DRAINER FOR STEAM ENGINE CYLINDERS.

We illustrate herewith an interesting device for draining water from steam engine cylinders, recently patented by Mr. Thos. D. Smith, an engineer in the employ of the Lehigh & Wilkesbarre Coal Co., Wilkesbarre, Pa., and used by that company in the hoisting engines at its collieries. Fig. 1 shows a cross-section of the device, and Fig. 2 a cross-section of a cylinder with the device attached. As shown in Fig. 2, the drainer contains



Figs. 1 and 2.—Cylinder Drainer for Steam Engines. Designed by Thos. D. Smith, Wilkesbarre, Pa.

two poppet valves which are normally held off their seats by springs, leaving an open connection between both ends of the cylinder and the drain pipe. In operation, however, the difference in steam pressures on the two sides of the piston in the steam cylinder causes the valve on that side of the drainer which is connected with the high pressure end of the cylinder to be closed, and the other valve to be opened wide. The drain pipe is thus always open to the cylinder on its exhausting end during the whole of the exhaust stroke, except just at the end, when closure of the exhaust port and compression of the steam remaining in the cylinder increases the pressure, shutting the drain valve on that end of the drainer and opening the valve on the other end. The drainer is especially valuable for hoisting engines, in which the cylinders are apt to collect so much water, on account of their frequent stoppage and cooling, that it is quite common to run them with the cylinder cocks always open, causing a great waste of steam. By the Smith drainer the drain pipe is open only to that end of the cylinder from which steam is being exhausted, so that it entirely saves the waste of steam through the cylinder cocks.

REPORT OF THE DEEP WATERWAYS COMMISSION.

The report of the Deep Waterways Commission, presented to Congress on Jan. 18, gives a detailed account of the work of the commission, and, after considering the question in its various aspects, presents these conclusions:

First—That it is entirely feasible to construct such canals and develop such channels as will be adequate to any scale of navigation that may be desired between the several great lakes and to the seaboard, and to conduct through the same domestic and foreign commerce, and that, in our opinion, it will be wise to provide for securing a channel of navigable depth of not less than twenty feet.

Second—That, starting from the heads of Lakes Michigan and Superior, the most eligible route is through the several lakes and their intermediate channels, and the proposed Niagara Ship Canal (Tonawanda to Olcott) to Lake Ontario; and that the Canadian seaboard may be reached from Lake Ontario by the way of the St. Lawrence River, and the American seaboard may be reached from Lake Ontario by the way of the St. Lawrence and Lake Champlain and the Hudson River, or by way of the Oswego, Oneida, Mohawk Valley and the Hudson River.

Third—That the alternative routes from Lake Ontario to the Hudson River require complete surveys and a full development of economic considerations to determine their relative availability.

Fourth—That a moderate control of the level of Lake Erie and of the Niagara River above Tonawanda may be justified in connection with the Niagara Ship Canal, the determination in this matter to rest on a full examination of the physical conditions.

Fifth—That the policy should contemplate the ultimate development of the largest useful capacity, and that all works should be planned on this basis, and that the actual execution should conform thereto, except in so far as the works may, without prejudice, be progressively developed with the actual demands of commerce.

Six—That it is practicable to develop the work in separate sections and the several sections in part by degrees, each step having its economic justification, so that benefits shall follow closely on expenditure, without awaiting the completion of the system as a whole.

Seven—That the completion of the entire system as quickly as it can be properly matured and economically executed is fully justified.

Eight—That the Niagara Ship Canal should first be undertaken, and incidentally the broadening and further deepening of the intermediate channels of the lakes, the same being in the logical order of development, and also requiring the least time for consideration.

The matters calling for early consideration are summarized as follows:

First—That complete surveys and examinations be made and all needful data to mature projects be procured for: Controlling the level of Lake Erie and projecting the Niagara Ship Canal; developing the Oswego-Oneida-Mohawk route; developing the St. Lawrence-Champlain route; improving the tidal Hudson River, and improving intermediate channels of the lakes.

Second—That the collecting and reducing of existing information, supplemented by reconnoissances and special investigations, be continued until the general questions have been fully covered.

Third—That a systematic measurement of the overflow of the several lakes and a final determination of their levels shall be undertaken.

Fourth—The complete surveys and investigations with measurements of the overflow of the several lakes and full investigation of collateral questions, will cost not less than $600,000, and require some years of time.

The measurement of the outflow of the lakes and the final levels may be done through other and existing agencies, and should be commenced at once. The estimated cost of doing this is $250,000, extended over a series of years. The specific surveys may cost $350,000, and will consume two or three years; and of this not less than $150,000 should be appropriated the first year.

THE PRICE OF ARMOR PLATE is to be further discussed in the U. S. Senate as the result of a report introduced by Senator Chandler, a member of the Naval Committee at the last session of Congress. Mr. Chandler fixes upon $300 per ton as a price permitting a fair margin of profit and declares any price in excess of that to be exorbitant. There is also evident a disposition in Congress looking towards the establishment of a government armor-plant, under the Navy Department; the advocates of this course stating that such a plant, even at a cost of $1,500,000, would be worth the expenditure as a check upon the two steel companies now having a monopoly of armor-making. It would enable the Secretary of the Navy to know what was a fair price, and prevent delay in furnishing armor caused by any combination of these firms to maintain a high price for armor.

A 12-IN. RIFLED GUN, especially built for firing high explosives, has been completed at the Washington Gun Shops, and is soon to be tested at Indian Head. This gun was built in accordance with a provision in the last Naval Bill appropriating $50,000 for testing high explosives in modern guns. In all respects, except the caliber, it is a 13-in. gun; and, if the gun survives the test, it is to be rebored to 13 ins. and placed on one of the new battleships. All high explosives, except dynamite, are to be tried in this gun; the purpose being to find an explosive for shells that can be safely fired from modern guns of long range, and that will pierce armor before explosion and yet be more powerful than the exploding charge now employed. Some most important results are expected, as many naval officers contend that modern rifled guns are just as efficient throwers of high explosives as the pneumatic guns at Sandy Hook, with the added advantages of much greater range and accuracy of fire.

MODERN DOCKS AT BOSTON are recommended by the Massachusetts State Commission on Docks and Terminal Facilities. It is recommended that the South Boston flats be used for this purpose, a frontage there of 9,150 ft. still belonging to the Commonwealth, contiguous to the railway system of New England and easily connected with it. It is also suggested that the Commonwealth obtain the title to certain flats on the north side of the harbor suitable for this purpose. The commission does not enter into details of construction, but the report considers the present condition of Boston harbor and describes what other cities have done, or are engaged in doing, in the line of harbor improvement. It is suggested that an expenditure of about $1,500,000 would have immediate and invaluable results upon the commercial status of Boston.

THE NEW YORK DOCK DEPARTMENT is actively preparing for the construction of five piers on the North River, between West Eleventh and Gansevoort Sts. Each pier is to be 80 ft. wide and from 677 to 730 ft. long, the spaces between the piers being 225 ft. wide. The estimated cost of the improvement is about $6,000,000, as 13th Ave., the existing piers and six solid blocks of buildings have first to be removed and the space to be occupied by the new piers must be first dredged out. This preliminary work is occasioned by the length of pier required for modern ocean steamers, and by the fact that the pier-head line of 1890 is nearly 650 ft. inside of the old line of 1871.

A CIVIL SERVICE EXAMINATION for the position of Engineer Inspector of Regulating, Paving and Grading, will be held Feb. 11 by the New York City Civil Service Commission. Aplications may be obtained by addressing S. William Briscoe, Secretary, New Criminal Court Building, New York city.

THE PROPOSED NEWTOWN SHIP CANAL, to connect Newtown Creek, on Long Island, with Flushing Bay, has been reported against by Major H. M. Adams, Corps of Engineers, U. S. A. The report states that the work would be enormously expensive with but few commensurate advantages. The canal would shorten the distance but little, as compared with the passage through Hell Gate, and there would be little difference in adverse currents. The only advantage of such a canal would be to avoid the dangers of the passage through Hell Gate, but sailing vessels could only use it with a fair wind, and steamers could only proceed at a slow speed, owing to the wash of the banks. The peculiar part of the scheme is that while the canal is being vigorously advocated in Congress, a representative of the Brooklyn "Eagle" could not find that the people of Brooklyn, or the manufacturers and property owners on Newtown Creek took any interest in the project one way or the other.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The 44th annual meeting of the society was held in New York city on Jan. 20 and 21. The business meeting, on Jan. 20, was called to order at 10:15 a. m., the President, Mr. T. C. Clarke, being in the chair, and a fair number of members present. After the usual preliminaries the Secretary, Mr. C. W. Hunt, read the reports of the Board of Direction, and the Finance Committee, and Mr. John Thomson presented his report as Treasurer. The substance of these reports is given below:

The announcement was made that the Norman Medal had been awarded to the paper by Mr. J. E. Greiner, on "What is the Life of an Iron Railroad Bridge;" and that the Rowland Prize had been awarded to the paper by Mr. H. St. L. Coppee, on "Bank Revetment on the Lower Mississippi River."

The next matter was the consideration of the place of the next annual convention. Over 200 votes had been received, covering places in all parts of the country, Quebec leading the list. Invitations were read from municipal officers at Nashville, Tenn. The matter was as usual referred to the Board of Direction with power to act.

There were no reports from special committees, but Mr. C. B. Dudley wrote that the Committee on Tests of Iron and Steel hoped soon to have its report ready, and Mr. Geo. F. Bond wrote that the Committee on Units of Measurement hoped to have its report ready for the next annual convention.

The next and most important business was the proposition to appoint a special committee to report on the proper manipulation of tests of cement. The following statement in this matter, prepared by the Board of Direction, was read by the Secretary.

At a business meeting of the society, held Nov. 4, 1896, it was unanimously voted, in accordance with Articles VI., Section 13, of the Constitution, to recommend to the Board of Direction the consideration of the appointment of a committee to report on the proper manipulation of tests of cement.

It is quite evident that a committee appointed under this resolution would be concerned only as to the manner and method of making tests and it would not be required to go into a general consideration of cements or cement specifications. It is a generally admitted fact that although a special committee of the society reported to the society in 1885 certain rules and regulations on this subject; nevertheless the development of the cement industry and the more general use of the material, has already caused those rules, although excellent at the time, to be now short of modern requirements. Under these rules it is possible for different experimenters to get widely different results, and such a state of affairs works not only to the detriment and disadvantage of the honest manufacturer, but also to the engineer user of the material. Your board has carefully considered this question and finds the following reasons in favor of appointing such a committee as is proposed by the resolution of the society:

1. That the methods of tests now known to the world as the standard of the American Society of Civil Engineers, while excellent at the time they were adopted by the society, are not the best possible now, and should be brought to conformity with present knowledge and the latest experience of this country and of Europe.

2. That a method of making tests should be so devised and specified in detail as to eliminate as far as practicable the personal element of the tester, in order that the test may more certainly represent the true character of the cement tested. It is a constantly recurring experience with cement manufacturers and users that tests giving unsatisfactory results are, after embarrassing delays and disputes, found to be unfair or incompetent because of some peculiarity in the manipulation. Methods of mixing and making briquettes and conducting the tests which would make these now variable factors uniform in all cases, would save a vast amount of time, trouble and expense. If the end desired can be accomplished and the tests of cements like those of metals be made to represent uniformly and truly the strength of the cement tested, the defects and virtues shown by tests will in every case be due to qualities dependent upon chemical constitution, methods of manufacture or treatment, and improvement in these latter would be more easy to discover and make.

The reasons in opposition to the appointment of such a committee appear to be as follows:

1. That it is inadvisable for the Society to adopt standards of any kind; that such work is better done when left to individuals.

2. That in the case in question it is doubtful whether it is possible to adopt any methods of preparing and testing briquettes whereby the personal equation can be reduced to a negligible quantity.

Your Board, however, is of the firm opinion that the reasons in favor of appointing the committee outweigh those in opposition, especially in view of the fact that a committee of the Society has already promulgated rules in this matter, which, for the reputation of the Society, should be kept at the highest attainable standard or else revoked.

It seems probable from what has been already said and written concerning the appointment of the proposed committees, that an effort may be made to reopen the entire subject of cement tests as considered by the former committee of the Society, and not confine the work to the simple matter of proper manipulation of tests. Your Board has given some attention to this matter, and is strongly of the opinion that the duties of the proposed committee should not be changed from those outlined in the resolution. Many and continuous efforts are being made in Europe by cement manufacturers and others by concerted as well as individual action, to arrive at some uniform requirements which shall become the standard specifications for cements. But as yet no uniform specification has been decided upon and the problem is probably

a more difficult one in this country than it is in Europe. It does not seem at the present time to be advisable to have a rigid set of specifications for cements in this country, where the character of the different products manufactured will necessarily vary with the materials available for use in the different regions, and where the whole process of manufacture is in a course of development which would apparently be rather dwarfed and confined than benefited by a set of specifications put forward by the American Society of Civil Engineers, to apply to the whole country.

There was but little discussion on this. One member took up the remark in the above statement as to test of iron and steel, and said that while the cost of tests of such material is but about 1-10 of 1% of the cost of the material, the cost of testing cement is about 20% of the cost of the material. The new methods would involve more laboratory testing work, and while this was an insurance of the quality, it might be questioned whether such percentage of cost for insurance was necessary. He considered that any revision should be in the line of simplification rather than mere amplification of tests. Mr. North stated that in one case, when a manufacturer was told of the strength his cement was showing, the quality was improved and a very much greater strength obtained, the result fully warranting a large expenditure on tests. Mr. Whinery also spoke in favor of the appointment of a committee. The question of submitting the appointment of such a committee to letter ballot was then voted on and carried unanimously.

A resolution offered by Mr. S. C. Thompson, in favor of legal protection against the unauthorized use of the title "C. E.,' or "Civil Engineer," was presented by letter, but was laid on the table, without discussion. This ended the proceedings about 11.45 a. m., and a recess was then taken until noon, when the report of the tellers on the ballot for officers was presented.

There were 457 ballots cast for officers, and the result of the election was as follows: President, Benjamin Morgan Harrod, New Orleans, La. (457); Vice-Presidents, George Henry Mendell, San Francisco, Cal. (457), and John Findley Wallace, Chicago, Ill. (453); Treasurer, John Thomson, New York city (457); Directors, Rudolph Hering, New York city (455); James Owen, Newark, N. J. (455); Henry Grant Morse, Wilmington, Del. (457); Benjamin Lincoln Crosby, St. Louis, Mo. (456); Henry Stevens Haines, Atlanta, Ga. (457), and Lorenzo M. Johnson, Eagle Pass, Tex. (456).

After the announcement of the vote the retiring president, Mr. T. C. Clarke, called the new president, Mr. B. M. Harrod, to the chair, and after a few remarks the meeting adjourned.

In the evening the Secretary, Mr. C. W. Hunt, gave an address on the origin, early history and subsequent growth of the Society. This address will be published in book form, handsomely printed and bound, and illustrated by some 35 portraits of the Society's presidents. The subscription price is $10, and the proceeds will go to the building fund for the new society house. The Board of Direction decided upon this step in order to induce many members who have not yet subscribed to that fund to do so in this way. Much interesting material has been gathered from various sources and put together in an attractive form, and the book will be of interest to every member of the Society. An appendix contains tables and diagrams showing the growth of this society as compared with leading foreign engineering societies.

On Jan. 21 there was an excursion to visit the new Croton Dam at Cornells, N. Y., by invitation of Mr. A. Fteley, M. Am. Soc. C. E., Chief Engineer of the Croton Aqueduct Commission. A special train was provided by the New York Central R. R., leaving the Grand Central Station at 9 a. m. for Croton Landing, 35 miles, from which point carriages conveyed the party to the dam.

The report of the Board of Direction and the financial reports were as follows:

Report of the Board of Direction.

Membership.—The changes in membership are shown in the following table:

	—Jan. 1, 1897.—			—During 1896:—					
				—Losses.—				Adtns.	
	Resident.	Non-resident.	Total.	By Transfer.	Resignation.	Dropped.	Death.	Transfer.	Election.
Hon. Mems.	4	4	8	..	..	..	..	..	..
Cor. Mems	3	3	6	..	..	..	..	..	..
Members	[1]231	1,021	1,252	..	10	8	18	[2]25	48
Assoc. Mems	70	212	282	19	2	..	2	[2]20	49
Associates	29	55	82	1	..	..	1	..	9
Juniors	105	213	318	25	3	1	2	..	46
Fellows	9	32	41	..	..	..	6	..	..
Subscribers	5	27	32	..	..	..	1	..	..
Totals	451	1,567	2,018	45	15	9	30	45	152

[1] 19 Associate Members, 1 Associate, 5 Juniors.

[2] 20 Juniors.

The net increase during the year has been 98.

The losses by death during the year number 30. They are as follows.—18 Members: Job Abbott, William Albert Allen, David Leonard Barnes, Max Joseph Becker, Louis Provost Evans, Francis Renatus Fava, Jr., William Harrison Grant, Robert Lewis Harris, John Houston, Robert Neilson, Norman James Nichols, Albert Franklin Noyes, James Clarence Post, Andrew Jackson Post, Joseph Russell Thomas, Christopher C. Waite, Orlando Belina Wheeler, John Allston Wilson. 2 Associate Members: Francis Asbury Lyte, James Hugh Stanwood. 1 Associate: Waterman Stone. 2 Juniors: Vernon Hill Gridley, John Joseph Tallon. 6 Fellows: Charles Lewis Colby, Alexander Samuel Diven, Francisco de Garay, James F. Joy, McRee Swift, Thomas Prosser. 1 Subscriber: George H. Nettleton.

Library.—The sum of $70.68 has been expended upon the library during the year, against $70.58 for the previous year. There have been 1,078 additions to the library, including 457 volumes, 361 pamphlets, and 26 specifications. The present number of titles in the library is 20,741.

Donations.—Under the will of the late McRee Swift, F. Am. Soc. C. E., a bequest of $1,000 was received in June, 1896, to be invested and the income to be devoted to the purchase of rare books and maps for the library of the society, and models for its museum. This bequest was made by Mr. Swift, who was one of the charter members of the Society, in memory of his father, "General Joseph G. Swift, born in 1783, died in 1865, the first graduate of the Military Academy at West Point, afterwards Chief of the Corps of Engineers, U. S. A., and subsequently to his resignation from the army, Chief Engineer of many undertakings, among them the New Orleans & Pontchartrain R. R. in 1829, and the Harlem R. R. in 1832."

Society House.—The expenditure for repairs and betterments of the Society House has been $92.48. The rooms have been kept open on Wednesday evenings during the year. During the months of November and December the experiment was tried of opening the library every evening for the convenience of the membership. The attendance was as follows:

Number of evenings open	45
Total attendance	36
Greatest number attending on any one evening (once)	4
Number of evenings when only one came	15
Number of eveings when no one came	22

Exclusive of the attendance at meetings, 1,172 members and others consulted the library during the year.

New Society House.—The purchase of the site for the New Society House, at Nos. 218 and 220 W. 57th St., was reported by your Board a year ago. The price paid was $80,000, $20,000 of which was paid in cash, and the balance, $60,000, left on mortgage. In March, 1896, it was decided to secure plans by instituting a competition open to all architects connected with the Society, and to a limited number of architects not so connected. Twelve designs were received, and that of Mr. C. L. W. Eidlitz selected. (Eng. News, May 28, 1896.) During the spring and summer the plans and specifications were perfected, but owing to the impossibility of securing a loan on favorable terms, proposals for the erection of the building were not asked for until after the presidential election. Pending this, however, the vault privilege, 1,500 sq. ft., was acquired from the city for $937.50 and the lots were excavated at a cost of $4,500. Meanwhile, also, negotiations were in progress for securing the necessary loan, and in November the Finance Committee was enabled to report an arrangement by which all the funds necessary for completing the new house could be secured from the Mutual Life Insurance Co. on most favorable terms.

After the receipt of competitive bids the contract for the erection of the building complete was let early in December to Charles T. Wills for $86,775, which, with the cost of excavation, already paid, makes the total $91,275, a sum only slightly in excess of that mentioned in last year's report as the probable cost. Work has been started, and it is expected that the building will be completed on or before Oct. 1, 1897.

The loan arranged for will provide all the funds to finish the work, and it will therefore not be necssary to dispose of the present house until a favorable opportunity offers, at which time the debt can be considerably reduced. Two circulars have been issued by the Board asking for subscriptions which have resulted in a total subscription of $139,170 from 277 persons, and $17,480 of this amount has been paid.

Attention is called to the fact that to date $32,362 in all has been expended on the new house, and, as only $17,480 has been received in cash subscriptions, it follows that $14,882 has already been furnished for this purpose out of the savings of the past few years. It is submitted that this fact demonstrates the financial ability of the Society to carry the work to a successful conclusion. Inasmuch, however, as, even with the strictest economy, there will still remain a debt upon the new house when completed, your Board hopes that those persons who have deferred subscribing until the project was placed on an assured basis, will now come forward and aid in the reduction of this debt.

Publications.—During the year a new system of publication has been in use. The Society publications, now, as heretofore, consist of Proceedings and Transactions, but with these changes: Proceedings are issued regularly on the fourth Wednesday of each month, except June and July, and contain advance copies of all papers to be presented, the record of the work of the Society, memoirs of deceased members, etc. Transactions are issued in volumes, which may be secured by members in standard cloth or half morocco binding at a price covering their cost. This has been much appreciated by members. Three hundred copies of Volume XXXV. were issued in binding, and 500 bindings have been ordered for future volumes.

The cost of publications has been $9,030, or $12,080, including time of officers, clerks and stenographers charged to publications. From this is to be deducted $1,893 received for advertisements, and $1,421 received for sale of publications, giving the net cost of publications as $8,795, while for 1895 this was $8,274. The average cost per page was $3.65 for 2,471 pages, as against $4.85 for 2,008 pages in 1895 and $6.22 for 1,748 pages in 1894.

Meetings.—The annual meeting, held in New York, Jan. 15 and 16, 1896, was attended by 150 of the Society members and a number of visitors. The attendance at the Twenty-eighth annual convention, held in San Francisco, Cal., was 62 members and 67 guests. There have been 18 regular meetings held at the Society House, at which the attendance has on several occasions exceeded 150, the average being 85. There were 25 formal papers presented at these meetings. In the oral discussion 104 persons took part, and correspondence from 118 was read.

Medals and Prizes.—The Norman medal for the year terminating Aug. 1, 1895, was awarded to Wm. Ham. Hall, M. Am. Soc. C. E., for his paper on "The Santa Ana Canal of the Bear Valley Irrigation Company." The Rowland Prize for the year terminating Aug. 1, 1895, was awarded to Wm. Ryan Hill, M. Am. Soc. C. E., for his paper entitled "The Water-Works of Syracuse, N. Y."

Report of the Secretary Acting as Auditor.

Receipts.

Balance on hand Dec. 31, 1895		$18,148.10
Entrance fees	$3,760.00	
Current dues of 1896	23,281.19	
Past dues	1,043.00	
Advance dues of 1897	8,390.36	
Sales of publications	1,421.62	
Badges	654.35	
Certificates of membership	163.50	
Advertisements	1,863.30	
Interest on securities and cash in trust company	1,190.57	
Sales of library duplicates	1.50	
Binding "Transactions"	652.92	
Legacy of McRee Swift	1,000.00	
Miscellaneous	48.51	
Rebate on taxes	11.77	
		43,482.59
Subscriptions to new society house		6,495.00
Total		$68,125.69

Disbursements.

Publications; net	$9,030.13	
Salaries	3,049.83	
		$12,079.96
Current business, salaries, office expenses, &c.		5,101.90
General printing and stationery		805.50
Postage		1,559.70
Library		1,374.81
Janitor		642.67
Badges		568.07
Contingencies		302.91
Gas		112.34
Water		17.55
Finance and accounts		1,452.68
House supplies and furniture		272.71
Certificates of membership		110.00
Fuel		128.25
Convention and annual meeting:		
Convention of 1896	840.45	
Annual meeting of 1896	561.34	
Annual meeting of 1897	24.86	
		1,426.65
Insurance		126.80
Safe deposit		16.00
Norman medal, Rowland and Collingwood prizes		127.16
Interest on mortgage:		
5% on $11,500	575.00	
For appraising premises, 127 E. 23d St	10.00	
		585.00
Taxes		492.20
Repairs and betterments		92.48
Binding "Transactions"		210.60
		$27,695.94
New society house:		
Purchase of property, 218 and 220 W. 57th St.	17,000.00	
Recording bond and mortgage	12.50	
Examination of title	378.24	
Interest on mortgage	1,800.82	
Compensation to competing architects	1,976.73	
Vault privilege	937.50	
Taxes	684.80	
For excavating lots	4,500.00	
C. W. Eidlitz's fee as architect	1,500.00	
For circulars, cuts, printing, &c.	183.28	
		28,973.87
		56,669.81
Balance in bank, in trust company, and in hands of secretary		11,455.88
Total		$68,125.69

Report of the Finance Committee.

The Committee refers to the report of the Board of Directors for matters in relation to expenditures connected with the new society house. During the year the total current receipts amounted to $42,482.59, or $2,812.58 in excess of the collections during 1895, this excess being due in large measure to a more prompt advance payment of annual dues. The total current expenditures during the year amount to $27,645.94, or $3,308.95 less than in 1895.